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Patent Office

Ottawa, Canada
K1A 0C9

(21) (A1) 2,093,290
(22) 1993/04/02
(43) 1993/10/07

5,026,2/42

(51) INTL.CL.[5] C07D-471/04; C07D-519/00; A61K-031/435; A61K-031/495

(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Imidazopyridines

(72) Mederski, Werner - Germany (Federal Republic of) ;
Dorsch, Dieter - Germany (Federal Republic of) ;
Beier, Norbert - Germany (Federal Republic of) ;
Schelling, Pierre - Germany (Federal Republic of) ;
Lues, Ingeborg - Germany (Federal Republic of) ;
Minck, Klaus-Otto - Germany (Federal Republic of) ;

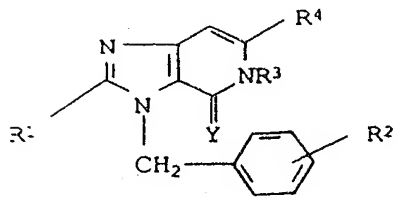
(71) Merck Patent Gesellschaft mit beschraenkter Haftung - Germany (Federal Republic of) ;

(30) (DE) P 42 11 474.8 1992/04/06

(57) 8 Claims

Abstract

Imidazopyridine derivatives of formula I:



I

wherein
R^1 to R^4 and Y have the meaning stated in Claim 1,
and their salts, exhibit antagonistic properties towards angiotensin II and have inter alia a hypotensive action.

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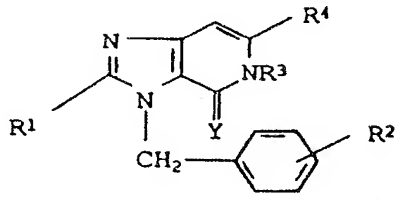
6100 D a r m s t a d t

Patent Claims

1. An imidazopyridine derivative of formula I:



I

wherein

R^1 is H or A,

R^2 is H, Hal, OH, OA, COOH, COOA, $CONH_2$, CN, NO_2, NH_2, NHA, $N(A)_2$, $NHCOR^5$, $NHSO_2R^5$ or 1H-5-tetrazolyl,

R^3 is H, cyanoalkyl, Ar-alkyl, cycloalkylalkyl having 3-8 C atoms in the cycloalkyl group, Het-alkyl, Ar'-alkyl, R^6-CO-alkyl, Ar-CO-alkyl or Het-CO-alkyl having, in each case, 1-6 C atoms in the 'alkyl' moiety, it being possible for an H atom in the 'alkyl' moiety to be replaced by a COOH or a COOA group,

R^4 is H or Hal,

R^5 and R^6 are in each case alkyl having 1-6 C atoms, wherein one or more H atom(s) can also be replaced by F,

Y is O or S,

A is alkyl, alkenyl or alkynyl in each case having up to 6 C atoms,

Ar is a phenyl group which is unsubstituted or monosubstituted by Hal, R^5, OH, OA, COOH, COOA, CN, NO_2, NH_2, NHA, $N(A)_2$, $NHCOR^5$, $NHSO_2R^5$ or 1H-5-tetrazolyl,

Ar' is a phenyl group substituted by Ar,

Het is a five or six-membered heteroaromatic radical having 1 to 3 N, O and/or S atoms, which can also be condensed with a benzene or pyridine ring, and

Hal is F, Cl, Br or I,

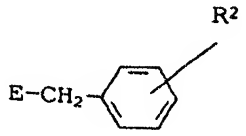
and their salts.

2. a) 2-Butyl-5-benzyl-3-p-carboxybenzyl-4,5-dihydro-4-oxo-3H-imidazo[4,5-c]pyridine and its salts;

b) 2-Butyl-3-p-carboxybenzyl-5-(2-thienylmethyl)-4,5-dihydro-4-oxo-3H-imidazo[4,5-c]pyridine and its salts;

c) 5-p-Aminobenzyl-2-butyl-3-p-carboxybenzyl-4,5-dihydro-4-oxo-3H-imidazo[4,5-c]pyridine and its salts.

3. Process for the preparation of imidazopyridines of formula I according to Claim 1, and their salts, characterised in that a compound of formula II



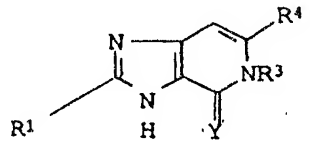
II

wherein

E is Cl, Br, I, a free OH group or an OH group which has been functionally modified to acquire reactivity, and

R^2 has the meaning stated in Claim 1,

is reacted with a compound of formula III



III

wherein
R^1, R^3, R^4 and Y have the meanings stated in Claim 1, or in that a compound of formula I is liberated from one of its functional derivatives by treatment with a solvolysing or hydrogenolysing agent,
and/or in that one or more radical(s) R^1, R^2, R^3, R^4 and/or Y in a compound of formula I are converted to one or more other radicals R^1, R^2, R^3, R^4 and/or Y, and/or a base or acid of formula I is converted to one of its salts.

4. Process for the preparation of pharmaceutical formulations, characterised in that a compound of formula I according to Claim 1, and/or one of its physiologically acceptable acid addition salts, are incorporated into a suitable dosage form together with at least one solid, liquid or semi-liquid excipient or adjunct.

5. Pharmaceutical formulation, characterised in that it contains at least one compound of formula I according to Claim 1, and/or one of its physiologically acceptable acid addition salts.

6. Compound of formula I according to Claim 1, and its physiologically acceptable acid addition salts, for the control of diseases.

7. Use of compounds of formula I according to Claim 1, and/or their physiologically acceptable acid addition salts, for the preparation of a drug.

8. Use of compounds of formula I according to Claim 1, and/or their physiologically acceptable acid addition salts, in the control of diseases.

Fetherstonhaugh & Co.,
Ottawa, Canada
Patent Agents

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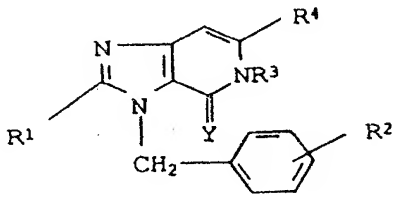
6100 D a r m s t a d t

Imidazopyridines

The invention relates to novel imidazopyridine derivatives of formula I:



I

wherein

R^1 is H or A,

R^2 is H, Hal, OH, OA, COOH, COOA, $CONH_2$, CN, NO_2, NH_2, NHA, $N(A)_2$, $NHCOR^5$, $NHSO_2R^5$ or 1H-5-tetrazolyl,

R^3 is H, cyanoalkyl, Ar-alkyl, cycloalkylalkyl having 3-8 C atoms in the cycloalkyl group, Het-alkyl, Ar'-alkyl, R^6-CO-alkyl, Ar-CO-alkyl or Het-CO-alkyl having, in each case, 1-6 C atoms in the 'alkyl' moiety, it being possible for an H atom in the 'alkyl' moiety to be replaced by a COOH or a COOA group,

R^4 is H or Hal,

R^5 and R^6 are in each case alkyl having 1-6 C atoms, wherein one or more H atom(s) can also be replaced by F,

Y is O or S,

A is alkyl, alkenyl or alkynyl in each case having up to 6 C atoms,

Ar is a phenyl group which is unsubstituted or monosubstituted by Hal, R^5, OH, OA, COOH, COOA, CN, NO_2, NH_2, NHA, $N(A)_2$, $NHCOR^5$, $NHSO_2R^5$ or 1H-5-

tetrazolyl,

Ar' is a phenyl group substituted by Ar,

Het is a five or six-membered heteroaromatic radical having 1 to 3 N , O and/or S atoms, which can also be condensed with a benzene or pyridine ring, and

Hal is F, Cl, Br or I,

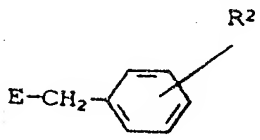
and their salts.

The object of the invention was to find novel compounds with valuable properties, especially compounds which can be used for the preparation of drugs.

It has been found that the compounds of formula I and their salts possess very valuable pharmacological properties coupled with a good tolerance. In particular, they exhibit antagonistic properties towards angiotensin II and can therefore be used as pharmaceutical active ingredients in human and veterinary medicine, especially for the prophylaxis and/or therapy of cardiac, circulatory and vascular diseases and in particular for the treatment of angiotensin II-dependent hypertension, aldosteronism and cardiac insufficiency, as well as disorders of the central nervous system, furthermore of hypertrophy and hyperplasy of the blood vessels and the heart, angina pectoris, cardiac infarction, haemorrhagic stroke, restenosis after angioplasty or by-pass surgery, arteriosclerosis, ocular hypertension, glaucoma, macular degeneration, hyperuricaemia, disturbances of the renal functions such as renal failure, diabetic complications such as nephropathia diabetica or retinopathia diabetica, psoriasis, angiotensinII-induces disturbances in female sexual organs, cognitive disorders, f.e. dementia, amnesia, disturbances of the functions of memory, states of fear, depressions and/or epilepsy.

These effects can be determined by conventional in vitro or in vivo methods such as those described for example in US Patent 4 880 804 and in WO 91/14367, as well as those described by A.T. Chiu et al., J. Pharmacol. Exp. Therap. 250, 867-874 (1989), and by P.C. Wong et al., ibid. 252, 719-725 (1990; in vivo, on rats).

The invention relates to the compounds of formula I, their salts and to a process for the preparation of these compounds and their salts, characterised in that a compound of formula II:



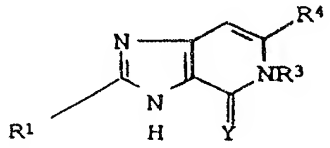
II

wherein

E is Cl, Br, I, a free OH group or an OH group which has been functionally modified to acquire reactivity, and

R^2 has the meaning stated in Claim 1,

is reacted with a compound of formula III



III

wherein

R^1, R^3, R^4 and Y have the meanings stated in Claim 1,

or in that a compound of formula I is liberated from one of its functional derivatives by treatment with a solvolysing or hydrogenolysing agent,

and/or in that one or more radical(s) R^1, R^2, R^3, R^4 and/or Y in a compound of formula I are converted to one or more other radicals R^1, R^2, R^3, R^4 and/or Y, and/or a base or acid of formula I is converted to one of its salts.

Hereinabove and hereinafter, the radicals or parameters R^1 to R^8, Y, A, Ar, Ar', Het, Hal and E have the meanings stated in formulae I and II, unless expressly indicated otherwise.

In the above formulae, A is particularly alkyl having 1-6, preferably 1, 2, 3 or 4 C atoms, preferably methyl, or else ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl or tert-butyl, or else pentyl, 1-, 2- or 3-methylbutyl, 1,1-, 1,2- or 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1-, 2-, 3- or 4-methylpentyl, 1,1-, 1,2-, 1,3-, 2,2-, 2,3- or 3,3-dimethylbutyl, 1- or 2-ethylbutyl, 1-ethyl-1-methylpropyl, 1-ethyl-2-methylpropyl or 1,1,2- or 1,2,2-trimethylpropyl. However, A can also be alkenyl or alkynyl in each case having 2-6, preferably 2, 3 or 4 C atoms, in particular vinyl, 1- or 2-propenyl (allyl), 1-propen-2-yl, 1-, 2- or 3-butenyl,

ethynyl, 1- or 2-propynyl (propargyl), 1-, 2- or 3-butynyl.

Accordingly, the radical OA is preferably methoxy, or else ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, sec-butoxy, tert-butoxy, vinyloxy, allyloxy, ethynyloxy or propargyloxy. The group COOA is preferably methoxycarbonyl or ethoxycarbonyl, or else propyloxycarbonyl, isopropyloxycarbonyl, butyloxycarbonyl, isobutyloxycarbonyl, allyloxycarbonyl, propargyloxycarbonyl. The group NHA is preferably methylamino or ethylamino. The group $N(A)_2$ is preferably dimethylamino or diethylamino.

Hal is preferably F, Cl or Br, or else I.

The radical Ar is preferably an unsubstituted phenyl group, or else preferably a phenyl group substituted in the p-position or substituted in the o- or m-position. Preferred substituents are COOH, COOA, NO_2 1H-5-tetrazolyl. Accordingly, Ar is preferably phenyl, o-, m- or (especially) p-carboxyphenyl, o, m- or (especially) p-methoxycarbonylphenyl, o-, m- or (especially) p-ethoxycarbonylphenyl, o-, m- or (especially) p-nitrophenyl, o-, m- or (especially) p-(1H-5-tetrazolyl)-phenyl furthermore preferably, o-, m- or (especially) p-aminophenyl, o-, m- or (especially) p-dimethylamino-phenyl, o-, m- or (especially) p-diethylaminophenyl, o-, m- or p-tolyl, o-, m- or p-trifluoromethylphenyl, o-, m- or p-hydroxyphenyl, o-, m- or p-methoxyphenyl, o-, m- or p-fluorophenyl, o-, m- or p-chlorophenyl, o-, m- or p-bromophenyl, o-, m- or p-iodophenyl, o-, m- or p-cyanophenyl, o-, m- or p-methylaminophenyl, o-, m- or p-acetamidophenyl, o-, m- or p-trifluoroacetamidophenyl, o-, m- or p-methylsulfonamidophenyl, o-, m- or p-trifluoromethylsulfonamidophenyl.

The radical Ar' is preferably 4-biphenylyl, 2'-carboxy-4-biphenylyl, 2'-methoxycarbonyl-4-biphenylyl, 2'-cyano-4-biphenylyl or 2'-(1H-5-tetrazolyl)-4-biphenylyl.

Het is preferably 2- or 3-furyl, 2- or 3-thienyl, 1-, 2- or 3-pyrrolyl, 1-, 2-, 4- or 5-imidazolyl, 1-, 3-, 4- or 5-pyrazolyl, 2-, 4- or 5-oxazolyl, 3-, 4- or 5-isoxazolyl, 2-, 4- or 5-thiazolyl, 3-, 4- or 5-isothiazolyl, 2-, 3- or 4-pyridyl, 2-, 4-, 5- or 6-pyrimidinyl, furthermore preferably 1,2,3-triazol-1-, -4- or -5-yl, 1,2,4-triazol-1-, -3- or -5-yl, 1,2,3-oxadiazol-4- or -5-yl, 1,2,4-oxadiazol-3- or -5-yl, 1,3,4-thiadiazol-2- or -5-yl, 1,2,4-thiadiazol-3- or -5-yl, 2,1,5-thiadiazol-3- or -4-yl, 3- or 4-pyridazinyl, pyrazinyl, 2-, 3-, 4-, 5-, 6- or 7-benzofuryl, 2-, 3-, 4-, 5-, 6- or 7-benzothienyl, 1-, 2-, 3-, 4-, 5-, 6- or 7-indolyl, 1-, 2-, 3-, 4-, 5-, 6- or 7-isoindolyl, 1-, 2-, 4- or 5-benzimidazolyl, 1-, 3-, 4-, 5-, 6- or 7-benzopyrazolyl, 2-, 4-, 5-, 6- or 7-benzoxazolyl, 3-, 4-, 5-, 6- or 7-benzisoxazolyl, 2-, 4-, 5-, 6- or 7-benzothiazolyl, 2-, 4-, 5-, 6- or 7-benzisothiazolyl, 4-, 5-, 6- or 7-benz-2,1,3-oxadiazolyl, 2-, 3-, 4-, 5-, 6-, 7- or 8-quinolyl, 1-, 3-, 4-, 5-, 6-, 7- or 8-isoquinolyl, 3-, 4-, 5-, 6-, 7- or 8-cinnolyl, 2-, 4-, 5-, 6-, 7- or 8-quinazolyl, 1H-1-, -2-, -5-, -6- or -7-imidazo[4,5-b]pyridyl, 3H-2-, -3-, -5-, -6- or -7-imidazo[4,5-b]pyridyl, 1H-1-, -2-, -4-, -6- or -7-imidazo[4,5-c]pyridyl, 3H-2-, -3-, -4-, -6- or -7-imidazo[4,5-c]pyridyl.

The term "Het" also includes the homologous radicals in which the heteroaromatic ring is substituted by one or more, preferably 1 or 2, A groups, preferably methyl and/or ethyl groups, for example 3-, 4- or 5-methyl-2-furyl, 2-, 4- or 5-methyl-3-furyl, 2,4-dimethyl-3-furyl, 3-, 4- or 5-methyl-2-thienyl, 3-methyl-5-tert.-butyl-2-thienyl, 2-, 4- or 5-methyl-3-thienyl, 2- or 3-methyl-1-pyrrolyl, 1-, 3-, 4- or 5-methyl-2-pyrrolyl, 3,5-dimethyl-4-ethyl-2-pyrrolyl, 2-, 4- or 5-methyl-1-imidazolyl, 4-methyl-5-pyrazolyl, 4- or 5-methyl-3-isoxazolyl, 3- or 5-methyl-4-isoxazolyl, 3- or 4-methyl-5-isoxazolyl, 3,4-dimethyl-5-isoxazolyl, 4-,or 5-methyl-2-thiazolyl, 4- or 5-ethyl-2-thiazolyl, 2- or

5-methyl-4-thiazolyl, 2- or 4-methyl-5-thiazolyl, 2,4-dimethyl-5-thiazolyl, 3-, 4-, 5- or 6-methyl-2-pyridyl, 2-, 4-, 5- or 6-methyl-3-pyridyl, 2- or 3-methyl-4-pyridyl, 4-methyl-2-pyrimidinyl, 4,6-dimethyl-2-pyrimidinyl, 2-, 5- or 6-methyl-4-pyrimidinyl, 2,6-dimethyl-4-pyrimidinyl, 3-, 4-, 5-, 6- or 7-methyl-2-benzofuryl, 2-ethyl-3-benzofuryl, 3-, 4-, 5-, 6- or 7-methyl-2-benzothienyl, 3-ethyl-2-benzothienyl, 1-, 2-, 4-, 5-, 6- or 7-methyl-3-indolyl, 1-methyl-5- or 6-benzimidazolyl, 1-ethyl-5- or 6-benzimidazolyl.

The radical Y is preferably O.

The radical R^1 is preferably A, in particular butyl, furthermore preferably propyl, pentyl or hexyl.

The radical R^2 is preferably COOH, furthermore preferably 1H-5-tetrazolyl, $COOCH_3$, $COOC_2H_5$, $CONH_2$, CN or NO_2.

The "alkyl" moiety in the radical R^3 is in the individual groups preferably $-CH_2-$ or $-CH_2CH_2-$, furthermore preferably $-CH(CH_3)-$, $-(CH_2)_3-$, $-(CH_2)_4-$, $-(CH_2)_5-$ or $-(CH_2)_6-$. Specifically, R^3 is preferably H; Ar-alkyl such as benzyl, 1- or 2-phenylethyl, o-, m- or (especially) p-carboxybenzyl, o-, m- or (especially) p-methoxycarbonylbenzyl, o-, m- or (especially) p-ethoxycarbonylbenzyl, o-, m- or (especially) p-nitrobenzyl, o-, m- or (especially) p-aminobenzyl, o-, m- or (especially) p-cyanobenzyl; cycloalkylalkyl such as cyclopropylmethyl, cyclobutyl-methyl, cyclopentylmethyl, cyclohexylmethyl, 1- or 2-cyclohexylethyl, cycloheptylmethyl, cyclooctylmethyl; Het-alkyl such as (especially) 2- or 3-thienylmethyl, 1- or 2-(2-thienyl)-ethyl; Ar'-alkyl such as 4-biphenylyl-methyl, 2'-carboxy-4-biphenylylmethyl, 2'-methoxycarbonyl-4-biphenylylmethyl, 2'-ethoxycarbonyl-4-biphenylylmethyl, 2'-cyano-4-biphenylylmethyl, 2'-(1H-5-tetrazolyl)-4-biphenylylmethyl; R^6-CO-alkyl such as 2-oxopropyl, 2-oxobutyl, 3-methyl-2-oxobutyl, 3,3-dimethyl-2-oxobutyl; Ar-CO-alkyl such as benzoyl-methyl, o-, m- or p-carboxybenzoylmethyl, o-, m- or p-methoxycarbonylbenzoylmethyl, o-, m- or

p-ethoxy-carbonylbenzoylmethyl, o-, m- or p-cyanobenzoylmethyl, o-, m- or p-nitrobenzoylmethyl, o-, m- or p-aminobenzoylmethyl; Het-CO-alkyl such as 2-thienylcarbonyl-methyl. If an H atom in the "alkyl" moiety of the radical R^3 is replaced by COOH or COOA, the said radical is preferably, for example, α-ethoxycarbonylbenzyl, α-cyclo-hexyl-α-ethoxycarbonylmethyl, 1-ethoxycarbonyl-2-phenyl-ethyl.

The radical R^4 is preferably H.

The radicals R^5 and R^6 are each preferably A such as methyl or ethyl, and trifluoromethyl, furthermore preferably fluoromethyl, difluoromethyl, pentafluoroethyl or heptafluoropropyl.

The compounds of formula I can possess one or more chiral centres and can therefore exist in different forms (optically active or optically inactive). Formula I includes all these forms.

Accordingly, the invention relates especially to those compounds of formula I in which at least one of said radicals has one of the preferred meanings indicated above. Some preferred groups of compounds can be expressed by the following partial formulae Ia to Id which correspond to the formula I and wherein the radicals not described more precisely have the meanings stated for formula I but wherein:

in Ia R^1 is alkyl having 1-6 C atoms;

in Ib R^2 is COOH, $COOCH_3$, $COOC_2H_5$, CN, $CONH_2$, NO_2 or 1H-5-tetrazolyl;

in Ic R^2 COOH, $COOCH_3$, $COOC_2H_5$, CN, $CONH_2$, NO_2 or 1H-5-tetrazolyl and is in the p position;

in Id R^2 is alkyl having 1-6 C atoms and

R^2 is COOH, $COOCH_3$, $COOC_2H_5$, CN, $CONH_2$, NO_2 or 1H-5-tetrazolyl.

Compounds which are furthermore preferred are those of the formulae:

Ie and Iae, Ibe, Ice and Ide, which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is H;

If and Iaf, Ibf, Icf and Idf, which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is Ar-alkyl;

Ig and Iag, Ibg, Icg and Idg which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is benzyl, carboxybenzyl, methoxycarbonylbenzyl, cyanobenzyl, nitrobenzyl or aminobenzyl;

Ih and Iah, Ibh, Ich and Idh which correspond to the formulae I and Ia, Ib, Ic and Id, but wherein additionally

R^3 is cycloalkylalkyl having 3-8 C atoms in the cycloakyl group;

Ii and Iai, Ibi, Ici and Idi which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is Het-alkyl;

Ij and Iaj, Ibj, Icj and Idj which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is Ar'-alkyl;

Ik and Iak, Ibk, Ick and Idk which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is R^6-CO-alkyl;

Il and Ial, Ibl, Icl and Idl which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is Ar-CO-alkyl;

Im and Iam, Ibm, Icm and Idm which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally R^3 is Het-CO-alkyl;

In and Ian, Ibn, Icn and Idn which correspond to the formulae I and Ia, Ib, Ic and Id, but wherein additionally

R^3 is H, benzyl, carboxybenzyl, methoxycarbonylbenzyl, cyanobenzyl, nitrobenzyl, aminobenzyl, α-carboxy-α-cyclohexylmethyl, α-cyclohexyl-α-methoxycarbonylmethyl, thienylmethyl, carboxy-4-biphenylylmethyl, methoxycarbonyl-4-biphenylylmethyl, (1H-5-tetrazolyl)-4-biphenylylmethyl or 3,3-dimethyl-2-oxobutyl;

Io and Iao, Ibo, Ico and Ido which correspond to the formulae I and Ia, Ib, Ic and Id but wherein additionally

R^3 is H, benzyl, p-carboxybenzyl, α-carboxybenzyl, p-methoxycarbonylbenzyl, α-methoxycarbonylbenzyl, p-cyanobenzyl, p-nitrobenzyl, p-aminobenzyl, α-carboxy-α-cyclohexylmethyl, α-cyclohexyl-α-methoxycarbonymethyl, 2-thienylmethyl, 2'-carboxy-4-biphenylylmethyl, 2'-methoxycarbonyl-4-biphenylylmethyl, 2'-(1H-5-tetrazolyl)-4-biphenylylmethyl or 3,3-dimethyl-2-oxo-butyl.

Particularly preferred compounds are all those of the abovementioned formulae in which additionally Y is O and/or R^4 is H.

The compounds of formula I and also the starting materials for their preparation are moreover prepared by methods known per se, such as those described in the literature (for example in the standard works like Houben-Weyl, Methoden der organischen Chemie (Methods of Organic Chemistry), Georg-Thieme-Verlag, Stuttgart, but especially in European Patent Application A2-0 430 709 and US Patent 4 880 804), under reaction conditions which are known and suitable for said reactions, it also being possible to make use of variants known per se, which are not mentioned in greater detail here.

If desired, the starting materials can also be formed in situ, so that they are not isolated from the reaction mixture but immediately reacted further to give the compounds of formula I.

The compounds of formula I can preferably be obtained by reacting compounds of formula II with compounds of formula III.

In the compounds of formula II, E is preferably Cl, Br, I or an OH group which has been functionally modified to acquire reactivity, such as alkylsulfonyloxy having 1-6 C atoms (preferably methylsulfonyloxy) or arylsulfonyloxy having 6-10 C atoms (preferably phenyl- or p-tolyl-sulfonyloxy).

The reaction of II with III is conveniently carried out by first converting III to a salt by treatment with a base, for example with an alkali metal

alcoholate such as CH_3ONa or potassium tert-butylate in an alcohol such as CH_3OH or in an amide such as dimethylformamide (DMF), or with an alkali metal hydride such as NaH or an alkali metal alcoholate in DMF, and then reacting said salt with II in an inert solvent, for example an amide such as DMF or dimethylacetamide, or a sulfoxide such as dimethyl sulfoxide (DMSO), conveniently at temperatures of between -20 and 100°, preferably of between 10 and 30°. Other suitable bases are alkali metal carbonates such as Na_2CO_3 or K_2CO_3, or alkali metal hydrogen carbonates such as $NaHCO_3$ or $KHCO_3$.

Some of the starting materials, especially those of formula II, are known. If they are not known, they can be prepared by known methods in analogy to known substances. Compounds of the formula III (R^3 = H) can be obtained for example by condensation of 3,4-diamino-6-R^4-1,2-dihydro-2-oxo- (or -2-thioxo-)-pyridines or of 3,4-diamino-2-chloro-6-R^4-pyridines with carboxylic acids of the formula R^1-COOH in the presence of polyphosphoric acid.

A compound of formula I can also be liberated from one of its functional derivatives by treatment with a solvolysing (for example hydrolysing) or hydrogenolysing agent.

Thus it is possible, using one of the methods indicated, to prepare a compound which has formula I but in which a 5-tetrazolyl group is replaced with a 5-tetrazolyl group functionally modified in the 1- position (protected by a protecting group). Examples of suitable protecting groups are: triphenylmethyl, which can be eliminated with HCl or formic acid in an inert solvent or solvent mixture, for example methanol or ether/dichloromethane/methanol; 2-cyanoethyl, which can be eliminated with NaOH in water/THF; and p-nitro-benzyl, which can be eliminated with H_2/Raney nickel in ethanol (compare European Patent Application A2-0 291 969).

It is also possible to convert one compound of formula I to another compound of formula I by converting

one or more of the radicals R^1, R^2, R^3, R^4 and/or Y to other radicals R^1, R^2, R^3, R^4 and/or Y, for example by reducing nitro groups to amino groups (for example by hydrogenation on Raney nickel or Pd/charcoal in an inert solvent such as methanol or ethanol), and/or functionally modifying free amino and/or hydroxyl groups, and/or freeing functionally modified amino and/or hydroxyl groups by solvolysis or hydrogenolysis, and/or replacing halogen atoms with CN groups (for example by reaction with copper(I) cyanide), and/or hydrolysing nitrile groups to COOH groups or to $CONH_2$ groups, or converting nitrile groups to tetrazolyl groups with hydrazoic acid derivatives, for example sodium azide in N-methyl-pyrrolidone or trimethyltin azide in toluene.

Thus, for example, free amino groups can be acylated in conventional manner with an acid chloride or anhydride, or free hydroxyl and/or NH groups can be alkylated with an unsubstituted or substituted alkyl or Ar-alkyl halide or with aldehydes such as formaldehyde, in the presence of a reducing agent such as $NaBH_4$ or formic acid, conveniently in an inert solvent such as methylene chloride or THF, and/or in the presence of a base such as triethylamine or pyridine, at temperatures of between -60 and +30°.

If desired, a functionally modified amino and/ or hydroxyl group in a compound of formula I can be freed by solvolysis or hydrogenolysis using conventional methods. Thus, for example, a compound of formula I containing an $NHCOR^5$ or COOA group can be converted to the corresponding compound of formula I containing an NH_2 or COOH group instead. Ester groups can be hydrolysed for example with NaOH or KOH in water, water/THF or water/dioxane, at temperatures of between 0 and 100°.

The reaction of nitriles of formula I (R^2 = CN or R^3 = cyanoalkyl) with hydrazoic acid derivatives leads to tetrazoles of formula I (R^2 = 1H-5-tetrazolyl and/or R^3 = 1H-5-tetrazolylalkyl). It is preferable to use trialkyltin azides such as trimethyltin azide, in an

inert solvent, for example an aromatic hydrocarbon such as toluene, at temperatures of between 20 and 150°, preferably of between 80 and 140°, or sodium azide in N-methylpyrrolidone at temperatures of between about 100 and 200°.

A base of formula I can be converted with an acid to the corresponding acid addition salt. Possible acids for this reaction are especially those which yield physiologically acceptable salts. Thus it is possible to use inorganic acids, for example sulfuric acid, nitric acid, hydrohalic acids such as hydrochloric acid or hydrobromic acid, phosphoric acids such as orthophosphoric acid, and sulfamic acid, as well as organic acids, especially aliphatic, alicyclic, araliphatic, aromatic or heterocyclic monobasic or polybasic carboxylic, sulfonic or sulfuric acids, for example formic acid, acetic acid, propionic acid, pivalic acid, diethylacetic acid, malonic acid, succinic acid, pimelic acid, fumaric acid, maleic acid, lactic acid, tartaric acid, malic acid, citric acid, gluconic acid, ascorbic acid, nicotinic acid, isonicotinic acid, methane- or ethane-sulfonic acid, ethanedisulfonic acid, 2-hydroxyethanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, naphthalene-monosulfonic and -disulfonic acids and lauryl sulfuric acid. Salts with physiologically unacceptable acids, for example picrates, can be used for isolating and/or purifying the compounds of formula I.

On the other hand, compounds of formula I containing COOH or tetrazolyl groups can be converted with bases (for example sodium or potassium hydroxide or carbonate) to the corresponding metal salts, especially alkali metal or alkaline earth metal salts, or to the corresponding ammonium salts. The potassium salts are particularly preferred.

The novel compounds of formula I and their physiologically acceptable salts can be used for the preparation of pharmaceutical formulations by

incorporation into a suitable dosage form together with at least one excipient or adjunct and, if desired, together with one or more other active ingredients. The resulting formulations can be used as drugs in human or veterinary medicine. Possible excipients are organic or inorganic substances which are suitable for enteral (for example oral or rectal) or parenteral administration or for administration in the form of an inhalation spray, and which do not react with the novel compounds, examples being water, vegetable oils, benzyl alcohols, polyethylene glycols, glycerol triacetate and other fatty acid glycerides, gelatin, soya lecithin, carbohydrates such as lactose or starch, magnesium stearate, talc and cellulose. Tablets, coated tablets, capsules, syrups, juices or drops, in particular, are used for oral administration; lacquered tablets and capsules with coatings or shells resistant to gastric juices are of special interest. Suppositories are used for rectal administration, and solutions, preferably oily or aqueous solutions, as well as suspensions, emulsions or implants, are used for parenteral administration. For administration as inhalation sprays, it is possible to use sprays containing the active ingredient either dissolved or suspended in a propellant or propellant mixture (for example hydrocarbons such as propane or butane, or fluorocarbons such as heptafluoropropane). It is convenient here to use the active ingredient in micronised form, it being possible for one or more additional physiologically compatible solvents, for example ethanol, to be present. Inhalation solutions can be administered with the aid of conventional inhalers. The novel compounds can also be lyophilised and the resulting lyophilisates used for example for the manufacture of injectable preparations. The indicated formulations can be sterilised and/or can contain adjuncts such as preservatives, stabilisers and/or wetting agents, emulsifiers, salts for influencing the osmotic pressure, buffer substances and colours and/or

flavourings. If desired, they can also contain one or more other active ingredients, for example one or more vitamins, diuretics or antiinflammatory agents.

The substances according to the invention are normally administered in analogy to other known, commercially available preparations, but in particular in analogy to the compounds described in US Patent 4 880 804, preferably in doses of between about 1 mg and 1 g, especially of between 50 and 500 mg per dosage unit. The daily dose is preferably between about 0.1 and 100 mg/kg, especially between 1 and 50 mg/kg of body weight. However, the particular dose for each individual patient depends on a very wide variety of factors, for example on the efficacy of the particular compound used, age, body weight, general state of health, sex, diet, time and mode of administration, rate of excretion, drug combination and severity of the particular disease to which the therapy is applied. Oral administration is preferred.

Hereinbefore and hereinafter, all temperatures are given in °C. In the following Examples, "conventional working-up" means: Water is added if necessary, the pH is adjusted to between 2 and 10 if necessary, depending on the constitution of the end product, extraction is carried out with ethyl acetate or methylene chloride, and the organic phase is separated off, dried over sodium sulfate, evaporated and purified by chromatography on silica gel and/or by crystallisation. Rf = Rf on silica gel (by thin layer chromatography; eluent: ethyl acetate/methanol 9:1). DOI = -4,5-dihydro-4-oxo-3H-imidazo[4,5-c]pyridine.

Example 1

19.1 g of 2-butyl-4,5-dihydro-4-oxo-1(or 3)H-imidazo[4,5-c]pyridine (m.p. 285-290°; obtainable by heating 3,4-diamino-2-chloropyridine and valeric acid in polyphosphoric acid at 100-140°, then 170-180°) are dissolved in 500 ml of DMF, 16.6 g of K_2CO_3 are added, the mixture is stirred for 45 min, a solution of 27.45 g of methyl p-bromomethylbenzoate is added dropwise, the mixture is stirred at 20° for 16 h, and water is added. The precipitate which has separated out is filtered off, washed with water, dried and chromatographed on silica gel. Using ethyl acetate and then ethyl acetate/methanol, first 2-butyl-3,5-bis-p-methoxycarbonylbenzyl-DOI (m.p. 124°) is obtained, and then 2-butyl-3-p-methoxycarbonylbenzyl-DOI (m.p. 219°).

Obtained analogously using p-bromomethylbenzonitrile are 2-butyl-3,5-bis-p-cyanobenzyl-DOI (m.p. 122.5°) and 2-butyl-3-p-cyanobenzyl-DOI (m.p. 201°).

Obtained analogously from 4,5-dihydro-4-oxo-2-propyl-1(or 3)H-imidazo[4,5-c]pyridine (m.p. 258°; obtainable from 3,4-diamino-2-chloropyridine and butyric acid in polyphosphoric acid) are 3,5-bis-p-methoxycarbonylbenzyl-2-propyl-DOI (oily; Rf 0.51 in ethyl acetate) and 3-p-methoxycarbonylbenzyl-2-propyl-DOI, m.p. 235°.

Example 2

Obtained in analogy to Example 1 from 2-butyl-5-(α-cyclohexyl-α-methoxycarbonylmethyl)-DOI (obtainable by benzylation of 2-butyl-4,5-dihydro-4-oxo-1(or 3)H-imidazo[4,5-c]pyridine to give the 3-benzyl-3H-compound, reaction with methyl α-bromo-α-cyclohexylacetate to give 2-butyl-3-benzyl-5-(α-cyclohexyl-α-methoxycarbonylmethyl)-DOI and elimination of the benzyl group by hydrogenolysis) and methyl p-bromomethylbenzoate is 2-butyl-5-(α-cyclohexyl-α-methoxycarbonylmethyl)-3-p-methoxycarbonylbenzyl-DOI, Rf 0.63.

Example 3

1.34 g of K tert.-butylate are added under N_2 to a solution of 3.39 g of 2-butyl-3-p-methoxycarbonylbenzyl-DOI (m.p. 218-219°) in 85 ml of DMF, the mixture is stirred at 20° for 10 min, a solution of 2.16 g of p-nitrobenzyl bromide in 35 ml of DMF is added, and the mixture is stirred at 20° for 2.5 h. Conventional working-up (chromatography on silica gel, ethyl acetate) results in 2-butyl-3-p-methoxycarbonylbenzyl-5-p-nitrobenzyl-DOI, m.p. 142°.

Obtained analogously using 2-thienylmethyl chloride is 2-butyl-3-p-methoxycarbonylbenzyl-5-(2-thienylmethyl)-DOI.

Obtained analogously using methyl α-bromo-α-cyclohexylacetate is 2-butyl-5-(α-cyclohexyl-α-methoxycarbonylmethyl)-3-p-methoxycarbonylbenzyl-DOI, Rf. 063.

Obtained analogously using methyl α-bromo-α-phenylacetate is 2-butyl-3-p-methoxycarbonylbenzyl-5-α-methoxycarbonylbenzyl-DOI, Rf 0.47 (ethyl acetate/hexane 9:1).

Obtained analogously using methyl 2-bromo-3-phenylpropionate is 2-butyl-3-p-methoxycarbonylbenzyl-5-(1-methoxycarbonyl-2-phenylethyl)-DOI, Rf 0.64.

Obtained analogously from 3-p-methoxycarbonylbenzyl-2-propyl-DOI are the following 3-p-methoxycarbonylbenzyl-2-propyl-DOI:

5-Benzyl-

5-p-Nitrobenzyl-

5-(3,3-Dimethyl-2-oxo-butyl)-.

Obtained analogously from 2-butyl-3-p-cyanobenzyl-DOI using methyl 4'-bromomethylbiphenyl-2-carboxylate is 2-butyl-3-p-cyanobenzyl-5-(2'-methoxycarbonylbiphenylyl-4-methyl)-DOI, m.p. 65°.

Obtained analogously from 2-butyl-3-p-cyanobenzyl-DOI using chloroacetonitrile is 2-butyl-3-p-cyanobenzyl-5-cyanomethyl-DOI, m.p. 197°.

Example 4

3 g of 2-butyl-4,5-dihydro-4-oxo-1(or 3)H-imidazo[4,5-c]pyridine are dissolved in 75 ml of methanol and, while stirring at 20°, a solution of 0.4 g of Na in 10 ml of methanol is added dropwise. The mixture is stirred for 45 min and then evaporated, the residue is dissolved in 30 ml of DMF and cooled to 0°, and, at this temperature, a solution of 3.7 g of p-nitrobenzyl bromide is added, and the mixture is stirred at 20° for 16 h. Evaporation and conventional working-up results, after chromatography (silica gel; ethyl acetate/toluene 7:3), first in 2-butyl-3,5-bis-p-nitrobenzyl-DOI (m.p. 142-143°) and then 2-butyl-3-p-nitrobenzyl-DOI (m.p. 193-194°).

Example 5

1 g of 2-butyl-3-p-methoxycarbonylbenzyl-5-p-nitrobenzyl-DOI is dissolved in 50 ml of methanol and hydrogenated on 0.5 g of Pd-c (5%) at 20° and under 1 bar until the H_2 uptake ceases, and the mixture is filtered and, after evaporation and chromatography on silica gel (ethyl acetate/methanol 9:1), results in 5-p-aminobenzyl-2-butyl-3-p-methoxycarbonylbenzyl-DOI, m.p. 59-60°.

Example 6

A mixture of 1 g of 2-butyl-3-p-methoxycarbonyl-benzyl-5-p-nitrobenzyl-DOI, 20 ml of 1 N sodium hydroxide solution, 6 ml of methanol and 18 ml of THF is stirred at 20° for 16 h and is acidified with hydrochloric acid, and conventional working-up results in 2-butyl-3-p-carboxy-benzyl-5-p-nitrobenzyl-DOI, m.p. 170°.

The following DOI are obtained analogously by hydrolysis of the corresponding methyl esters:

5-p-Aminobenzyl-2-butyl-3-p-carboxybenzyl-, m.p. 130°

2-Butyl-3-p-carboxybenzyl-, m.p. 249°

2-Butyl-3,5-bis-p-carboxybenzyl, m.p. 150°

3-p-Carboxybenzyl-2-propyl-, m.p. 289°

3,5-Bis-p-carboxybenzyl-2-propyl-, m.,p. 209°

5-Benzyl-3-p-carboxybenzyl-2-butyl-, m.p. 212°, K salt, m.p. > 300°

3-p-Carboxybenzyl-5-p-nitrobenzyl-2-propyl-, m.p. 300°
2-Butyl-3-p-carboxybenzyl-5-(2-thienylmethyl)-, m.p. 201°
3-p-Carboxybenzyl-5-(3,3-dimethyl-2-oxo-butyl)-2-propyl-, m.p. 195°
2-Butyl-3-p-carboxybenzyl-5-α-carboxy-α-cyclohexyl-methyl-, m.p. 195°
2-Butyl-3-p-carboxybenzyl-5-α-carboxybenzyl-, sesquihydrate, m.p. 234°
2-Butyl-3-p-carboxybenzyl-5-(1-carboxy-2-phenyl-ethyl)-, m.p. 253°.

Example 7

Reaction of 2-butyl-3-p-cyanobenzyl-5-(2'-methoxycarbonylbiphenyl-4-methyl)-DOI in analogy to Example 6 with sodium hydroxide solution/methanol/THF results in 2-butyl-3-p-carbamoylbenzyl-5-(2'-carboxy-biphenylyl-4-methyl)-DOI, m.p. 241°, as main product.

Example 8

a) A mixture of 4.21 g of 2-butyl-3,5-bis-p-cyano-benzyl-DOI, 41.2 g of trimethyltin azide and 300 ml of toluene is boiled for 72 h and evaporated. The residue is stirred with 100 ml of methanolic hydrochloric acid at 20° for 2 h, and conventional working-up (saturated NaCl solution/dichloromethane) results in 2-butyl-3,5-bis-[p-(1H-5-tetrazolyl)-benzyl]-DOI, m.p. 272°.

Obtained analogously from 2-butyl-3-p-cyanobenzyl-DOI is 2-butyl-3-[p-(1H-5-tetrazolyl)benzyl]-DOI.

Obtained analogously from 2-butyl-3-p-cyanobenzyl-5-(2'-methoxycarbonylbiphenylyl-4-methyl)-DOI is 2-butyl-5-(2'-methoxycarbonylbiphenylyl-4-methyl)-3-[p-(1H-5-tetrazolyl)benzyl]-DOI, m.p. 154°.

Obtained analogously from 2-butyl-3-p-cyanobenzyl-5-cyanomethyl-DOI is 2-butyl-3-[p-(1H-5-tetrazolyl)-benzyl]-5-(1H-5-tetrazolylmethyl)-DOI, m.p. 276° (decomposition).

The following Examples relate to pharmaceutical formulations containing active ingredients of formula I or their salts.

Example A: Tablets and coated tablets

Tablets of the following composition are produced by compression in conventional manner and, where required, are provided with a conventional sucrose-based coating:

Active ingredient of formula I	100	mg
Microcrystalline cellulose	278.8	mg
Lactose	110	mg
Maize starch	11	mg
Magnesium stearate	5	mg
Finely divided silicon dioxide	0.2	mg

Example B: Hard gelatin capsules

Conventional two-piece hard gelatin capsules are each filled with

Active ingredient of formula I	100	mg
Lactose	150	mg
Cellulose	50	mg
Magnesium stearate	6	mg

Example C: Soft gelatin capsules

Conventional soft gelatin capsules are filled with a mixture of 50 mg of active ingredient and 250 mg of olive oil in each case.

Example D: Ampoules

A solution of 200 g of active ingredient in 2 kg of 1,2-propanediol is made up to 10 l with water and filled into ampoules so that each ampoule contains 20 mg of active ingredient.

Example E: Aqueous suspension for oral administration

An aqueous suspension is prepared in conventional manner. The unit dose (5 ml) contains 100 mg of active ingredient, 100 mg of sodium carboxymethylcellulose, 5 mg of sodium benzoate and 100 mg of sorbitol.

SUBSTITUTE

REMPLACEMENT

SECTION is not Present

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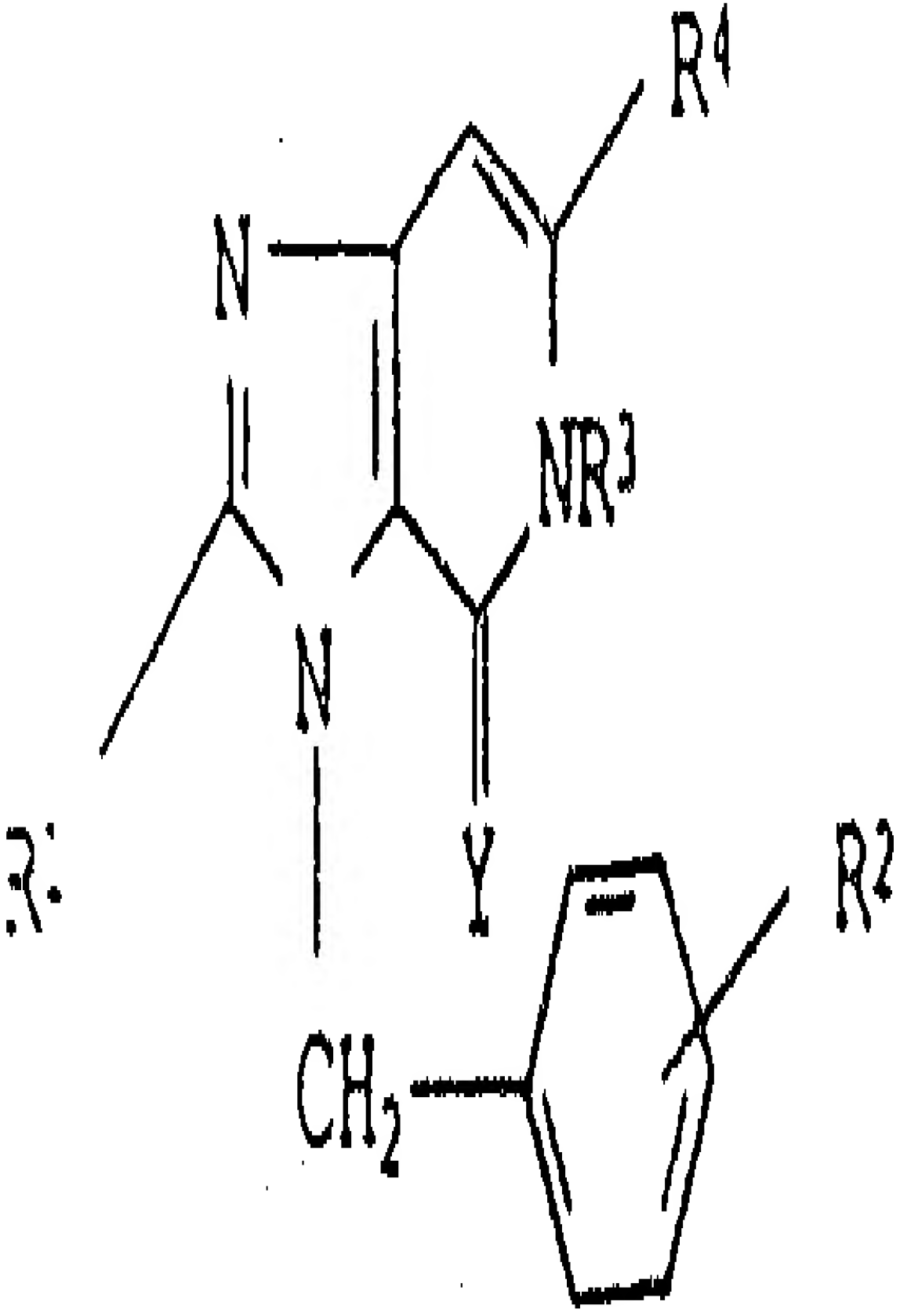
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(21) (A1) 2,158,996

(86) 1994/03/14

(43) 1994/10/13

(51) Int.Cl.[6] C07D 471/04; C07D 487/04; C07F 9/547; A01N 43/90; A01N 57/24

(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Substituted Heteroannulated Imidazoles and Their Use as Herbicides

(72) Bassner, Bernd - Germany (Federal Republic of) ;
Lieb, Folker - Germany (Federal Republic of) ;
Santel, Hans-Joachim - U.S.A. ;
Dollinger, Markus - Germany (Federal Republic of) ;

(71) Bayer Aktiengesellschaft - Germany (Federal Republic of) ;

(30) (DE) P 43 09 969.6 1993/03/26

(57) 10 Claims

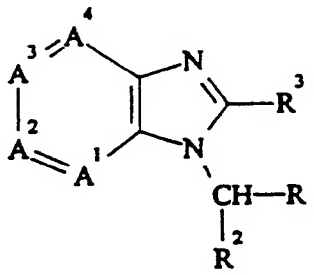
2158996

(57) Abstract

New substituted heteroannulated imidazoles having general formula (I), in which R^1, R^2, R^3, A^1, A^2, A^3 and A^4 have the meanings given in the description, are disclosed, as well as a process for preparing the same and their use as herbicides.

Patent Claims

1. New substituted hetero-fused imidazoles of the general formula (I)



in which

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy and aryl,

R^2 represents hydroxyl, cyano or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, amino, aminocarbonyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, dialkoxyphosphonyl, (hetero)aryl, (hetero)arylcarbonyl, (hetero)aryloxycarbonyl, (hetero)arylcarbonyloxy and (hetero)arylamino-carbonylaminocarbonyloxy,

R^3 represents cyano, halogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkinyloxy, dialkoxyphosphonyl, amino, aminocarbonyl and aryl,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3),

where

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, halogen, cyano, nitro or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy, alkylthio, alkylsulphinyl, alkylsulphonyl and cycloalkyl, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl, but where at least one of the substitutents X^1, X^2 or X^3 represents halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, alkylsulphonyl, or represents optionally substituted fused dioxyalkylene, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl.

2. New substituted hetero-fused imidazoles of the general formula (I) according to Claim 1, characterized in that

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl and alkoxy, each of which has 1 to 8 carbon atoms, or represents phenyl which

is optionally monosubstituted or polysubstituted by identical or different substituents, suitable substituents being:

halogen, cyano, nitro in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 6 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl or halogenoalkylsulphonyl each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 6 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or phenyl which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 6 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms,

R^2 represents hydroxyl, cyano or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphonyl, each of which has up to 8 carbon atoms in the individual alkyl or alkenyl or alkinyl moieties and each of these radicals optionally being monosubstituted or polysubstituted by identical or different substituents, suitable substituents in each case being:

fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1 to 8 carbon atoms, or aryl having 6 to 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 5 hetero atoms (in

particular nitrogen, oxygen and/or sulphur), these aryl or heteroaryl substituents in each case optionally being monosubstituted or polysubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 8 carbon atoms, straight-chain or branched alkenyl having 2 to 8 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 8 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 8 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 8 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 8 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 6 carbon atoms in the alkanediyl moiety, arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and 1 to 8 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents aryl, arylcarbonyl, aryloxycarbonyl, arylcarbonyloxy

or arylaminocarbonylaminocarbonyloxy, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylaminocarbonylaminocarbonyloxy, each of which has 2 to 9 carbon atoms and 1 to 5 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the aryl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, iodine or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of cycloalkyl, alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkenyloxy, each of which has up to 8 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties, suitable substituents in each case being: fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1 to 8 carbon atoms, or aryl having 6 to 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 5 hetero atoms (in particular nitrogen, oxygen and/or sulphur), each of these aryl or heteroaryl radicals optionally being monosubstituted or polysubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 8 carbon atoms,

straight-chain or branched alkenyl having 2 to 8 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 8 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 8 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 8 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 8 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 6 carbon atoms in the alkanediyl moiety, arylalkyl, aryalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and 1 to 8 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^3 furthermore represents aryl having in each case 6 to 10 carbon atoms in the aryl moiety which is in each case optionally monosubstituted or polysubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3), and

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, fluorine, chlorine, bromine, iodine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 8 carbon atoms, cycloalkyl having 3 to 8 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 6 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 8 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 6 carbon atoms, halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, aryloxy, arylthio, arylsulphinyl,

arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1, and

where at least one of the substituents X^1, X^2 or X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogeno-alkylthio, halogeno-alkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or represents straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 6 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 8 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 6 carbon atoms, halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents in the aryl moiety, suitable aryl substituents in each case being those mentioned in the case of R^1,

X^1, X^2 and X^3 furthermore represent aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1.

3. New substituted hetero-fused imidazoles of the general formula (I) according to Claim 1, characterized in that

R^1 represents hydrogen, or a straight-chain or branched radical from the series consisting of alkyl and alkoxy, each of which has 1 to 6 carbon atoms and each of which is unsubstituted or substituted, or represents phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable substituents being:

fluorine, chlorine, bromine, iodine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 4 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl or halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, or phenyl which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon

atoms and 1 to 9 identical or different halogen atoms, halogen in each case representing fluorine, chlorine, bromine or iodine,

R^2 represents hydroxyl, cyano, or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy and dialkoxyphosphonyl, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of fluorine, chlorine, bromine and iodine, or represents alkyl, alkenyl or alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphonyl, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 6 carbon atoms, or aryl having 6 or 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 4 hetero atoms (in particular nitrogen, oxygen and/or sulphur), each of these aryl or heteroaryl radicals optionally being monosubstituted to trisubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 6 carbon atoms, straight-chain or branched alkenyl having 2 to 6 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl

substituents having 1 to 6 carbon atoms, or cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 7 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 6 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 5 carbon atoms in the alkanediyl moiety, arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and 1 to 6 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents aryl, arylcarbonyl, aryloxycarbonyl, arylcarbonyloxy or arylaminocarbonylaminocarbonyloxy, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned under R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylamino-carbonylaminocarbonyloxy, each of which has 2 to 9 carbon atoms and 1 to 4 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the aryl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, iodine, or a straight-chain or

branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl and alkylcarbonyloxy, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of fluorine, chlorine, bromine and iodine, or represents cycloalkyl, alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxy-phosphonyl, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable substituents in each case being:

fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1 to 6 carbon atoms, or aryl having 6 or 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 4 hetero atoms (in particular nitrogen, oxygen and/or sulphur), each of these aryl or heteroaryl radicals optionally being monosubstituted to trisubstituted by identical or different substituents, suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 6 carbon atoms, straight-chain or branched alkenyl having 2 to 6 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 6 carbon atoms, or cycloalkyl, cycloalkylcarbonyl, or cycloalkyloxycarbonyl, each of which has 3 to 7 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl,

alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 6 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 5 carbon atoms in the alkanediyl moiety, or arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and 1 to 6 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted to trisubstituted by identical or different substituents in the aryl moiety, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^3 furthermore represents aryl having in each case 6 or 10 carbon atoms in the aryl moiety which is in each case optionally monosubstituted to pentasubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3), and

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, fluorine, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of

which has 1 to 6 carbon atoms, cycloalkyl having 3 to 7 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkyl-sulphinyl, halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, or divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 4 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 7 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 4 carbon atoms, halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1, and

where at least one of the substituents X^1, X^2 and X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, or divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 4 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 7 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 4 carbon atoms, halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl arylaminocarbonyl, or arylmethylsulphonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 or 10 carbon atoms in the aryl moiety, such as phenyl or naphthyl, and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1.

4. New substituted hetero-fused imidazoles of the general formula (I) according to Claim 1, characterized in that

R^1 represents hydrogen or a straight-chain or branched radical from the series consisting of alkyl and alkoxy, each of which has 1 to 4 carbon atoms and each of which is unsubstituted or substituted, or represents phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents being:

fluorine, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 3 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl or halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, halogen in each case representing fluorine, chlorine or bromine,

R^2 represents hydroxyl, cyano or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy and dialkoxyphosphonyl, each of which has up to 4 carbon atoms in the

individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents from the series consisting of fluorine, chlorine and bromine, or represents alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphoryl, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties, and each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 3 carbon atoms or phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable phenyl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 4 carbon atoms, straight-chain or branched alkenyl having 2 to 4 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 4 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 6 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 4 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 4 carbon atoms in the alkanediyl moiety, phenylalkyl, phenylalkylcarbonyl or phenylalkyloxycarbonyl, each of which has 1 to 4

carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, or phenyl, phenylcarbonyl or phenyloxycarbonyl, each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents phenyl, phenylcarbonyl, phenyloxycarbonyl, phenylcarbonyloxy or phenylaminocarbonylaminocarbonyloxy, each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylaminocarbonylaminocarbonyloxy, each of which have 2 to 9 carbon atoms and 1 to 3 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the phenyl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl and alkylcarbonyloxy, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents from the series consisting of fluorine, chlorine and bromine, or represents alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphoryl, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl

moieties and each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 3 carbon atoms or phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable phenyl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 4 carbon atoms, straight-chain or branched alkenyl having 2 to 4 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, in each case optionally monosubstituted or disubstituted (identically or differently by straight-chain or branched alkyl having 1 to 4 carbon atoms) carbamoyl, thiocarbamoyl or sulphamoyl, cycloalkyl, cycloalkylcarbonyl, or cycloalkyloxycarbonyl, each of which has 3 to 6 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 4 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 4 carbon atoms in the alkanediyl moiety, phenylalkyl, phenylalkylcarbonyl or phenylalkyloxycarbonyl, each of which has 1 to 4 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, or phenyl, phenylcarbonyl or phenyloxycarbonyl, each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case

of R^1,

R^3 furthermore represents phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form, and

X^1, X^2 and X^3 independently of one another in each case represent hydrogen, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 4 carbon atoms, cycloalkyl having 3, 5 or 6 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or represent divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 3 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3, 5 or 6 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or

disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 3 carbon atoms, halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, or phenylcarbonyl, phenylsulphonyl, phenylaminocarbonyl or phenylmethylsulphonyl, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent phenyl, phenyloxy, phenylthio, phenylsulphinyl, phenylsulphonyl, phenylsulphonyloxy, phenylcarbonyl, phenyloxycarbonyl, phenylthiomethylsulphonyl or phenylazo, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1, and

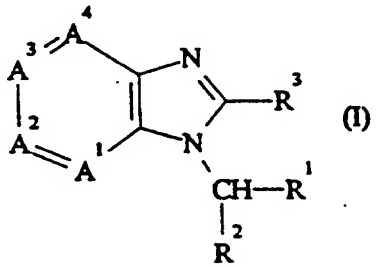
where at least one of the substituents X^1, X^2 and X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or represents straight-chain or branched alkylsulphonyl having 1 to 3 carbon atoms, or represents divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and/or straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 3 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3, 5 or 6 carbon atoms in the cycloalkyl moiety, or amino or

aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 3 carbon atoms, halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, or phenylcarbonyl, phenylsulphonyl, phenylaminocarbonyl or phenylmethylsulphonyl, each of which is optionally monosubstituted to trisubstituted by identical or different substituents in the phenyl moiety, suitable phenyl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent phenyl, phenylthio, phenylsulphinyl, phenylsulphonyl, phenylsulphonyloxy, phenylcarbonyl, phenyloxycarbonyl, phenylthiomethylsulphonyl or phenylazo, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1.

5. Process for the preparation of new substituted fused imidazoles of the general formula (I)



(I)

in which

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl,

alkoxy and aryl,

R^2 represents hydroxyl, cyano or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, amino, aminocarbonyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, dialkoxyphosphonyl, (hetero)aryl, (hetero)aryl-carbonyl, (hetero)aryloxycarbonyl, (hetero)arylcarbonyloxy and (hetero)arylaminocarbonyl-aminocarbonyloxy,

R^3 represents cyano, halogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkinyloxy, amino, aminocarbonyl and aryl,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form,

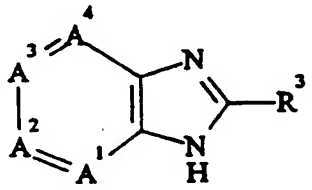
where,

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, halogen, cyano, nitro or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy, alkylthio, alkylsulphinyl, alkylsulphonyl and cycloalkyl, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted

amino or aminocarbonyl, or represents in each case optionally substituted aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl, but where at least one of the substituents X^1, X^2 or X^3 represents halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, alkylsulphonyl, or represents optionally substituted fused dioxyalkylene, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl,

characterized in that

1H-substituted hetero-fused imidazoles of the formula (II)

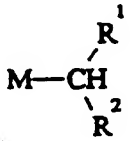


(II)

in which

A^1, A^2, A^3, A^4 and R^3 have the abovementioned meanings

are reacted with compounds of the formula (III)



(III)

in which

M represents a suitable leaving group and

R^1 and R^2 have the abovementioned meanings,

if appropriate in the presence of a diluent and if appropriate in the presence of a reaction auxiliary.

6. Herbicidal compositions, characterized in that they comprise at least one substituted hetero-fused imidazole of the formula (I) according to Claims 1 to 5.

7. Method of combating undesirable plants, characterized in that substituted hetero-fused imidazoles of the general formula (I) according to Claims 1 to 5 are allowed to act on plants and/or their environment.

8. Use of substituted, hetero-fused imidazoles of the general formula (I) according to Claims 1 to 5 for combating undesirable plants.

9. Process for the preparation of herbicidal and insecticidal compositions, characterized in that substituted hetero-fused imidazoles of the general formula (I) according to Claims 1 to 5 are mixed with extenders and/or surface-active substances.

10. Use of substituted hetero-fused imidazoles of the general formula (I) according to Claims 1 to 5 for combating animal pests.

2158996

BAYER AKTIENGESELLSCHAFT **51368 Leverkusen**
Konzernzentrale RP
Patente Konzern WA/HB

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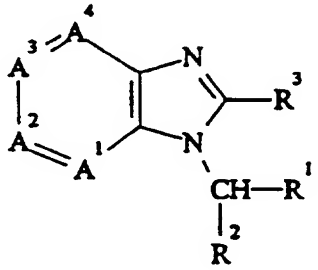
~~TEXT~~ TRANSLATION

SUBSTITUTED HETERO-FUSED IMIDAZOLES AND THEIR USE AS HERBICIDES

The invention relates to new substituted hetero-fused imidazoles, to a process for their preparation, and to their use as herbicides.

It is known that certain benzimidazoles have insecticidal properties, but nothing has been disclosed about the use of hetero-fused imidazoles as herbicides.

There have now been found new substituted hetero-fused imidazoles of the general formula (I)



(I)

in which

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy and aryl,

R^2 represents hydroxyl, cyano or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of

alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, amino, aminocarbonyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, dialkoxyphosphonyl, (hetero)aryl, (hetero)arylcarbonyl, (hetero)aryloxycarbonyl, (hetero)arylcarbonyloxy and (hetero)arylaminocarbonylamino-carbonyloxy,

R^3 represents cyano, halogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkinyloxy, amino, aminocarbonyl and aryl,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

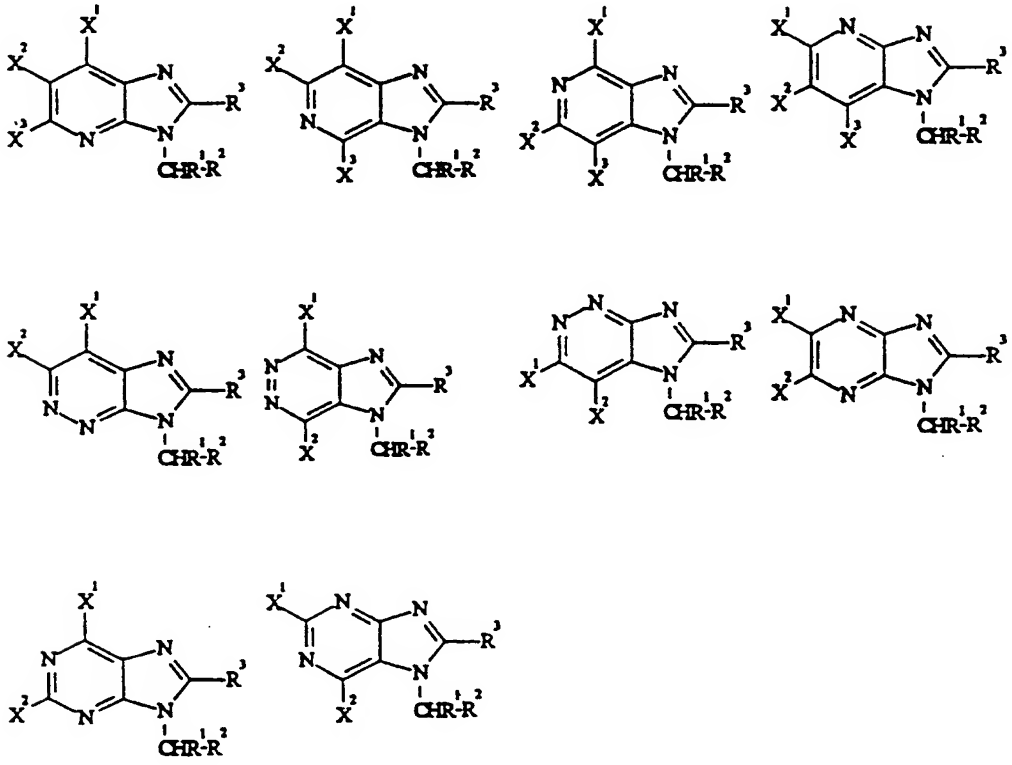
CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3),

where

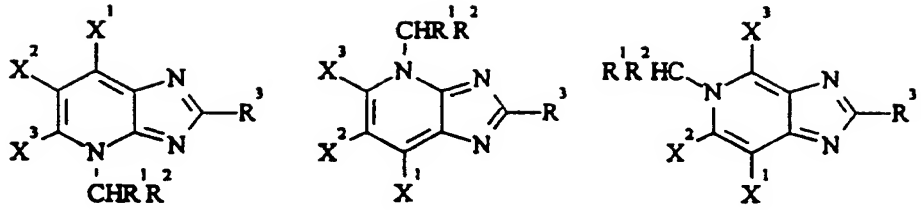
X^1, X^2 and X^3 in each case independently of one another represent hydrogen, halogen, cyano, nitro or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy, alkylthio, alkylsulphinyl, alkylsulphonyl and cycloalkyl, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl, but where at least one of the substitutents X^1, X^2 or X^3 represents halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, alkylsulphonyl, or represents

optionally substituted fused dioxyalkylene, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl.

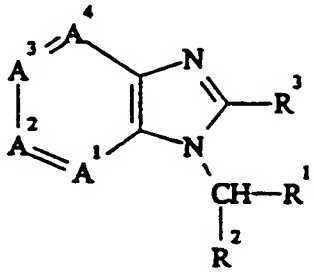
Depending on the nature and number of substitutents, the compounds of the formula (I) can, if appropriate, exist as geometric and/or optical isomers or regioisomers or variously composed isomer mixtures of these, but also in the form of positional isomers, for example in the following variations:



or, for example, the following variations are also possible:



Furthermore, it has been found that the new substituted hetero-fused imidazoles of the general formula (I)



(I)

in which

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy and aryl,

R^2 represents hydroxyl, cyano or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, amino, aminocarbonyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, dialkoxyphosphonyl, (hetero)aryl, (hetero)arylcarbonyl, (hetero)aryloxycarbonyl, (hetero)arylcarbonyloxy and (hetero)arylaminocarbonylaminocarbonyloxy,

R^3 represents cyano, halogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkinyloxy, amino, aminocarbonyl and aryl,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the

heterofused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

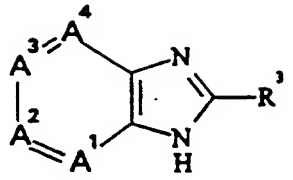
CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3),

where,

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, halogen, cyano, nitro or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl, alkoxy, alkylthio, alkylsulphinyl, alkylsulphonyl and cycloalkyl, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl, but where at least one of the substituents X^1, X^2 or X^3 represents halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, alkylsulphonyl, or represents optionally substituted fused dioxyalkylene, or represents hydroxycarbonyl, alkylcarbonyl, alkoxycarbonyl, cycloalkyloxycarbonyl, or represents in each case optionally substituted amino or aminocarbonyl, or represents in each case optionally substituted aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylazo or arylthiomethylsulphonyl,

are obtained when

a) 1H-substituted hetero-fused imidazoles of the formula (II)

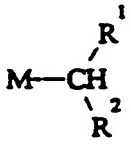


(II)

in which

A^1, A^2, A^3, A^4 and R^3 have the abovementioned meanings

are reacted with compounds of the formula (III)



(III)

in which

M represents a suitable leaving group and

R^1 and R^2 have the abovementioned meanings,

if appropriate in the presence of a diluent and if appropriate in the presence of a reaction auxiliary.

Finally, it has been found that the new substituted hetero-fused imidazoles of the general formula (I) have good herbicidal activity.

Surprisingly, the new substituted hetero-fused imidazoles of the general formula (I) according to the invention show a considerable herbicidal activity against problem weeds combined with a similarly good tolerance by important crop plants.

Formula (I) provides a general definition of the substituted hetero-fused imidazoles according to the invention. Preferred compounds of the formula (I) are those in which

R^1 represents hydrogen or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of alkyl and alkoxy, each of which has 1 to 8 carbon atoms, or represents phenyl which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable substituents being:

halogen, cyano, nitro in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 6 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkyl-sulphinyl or halogenoalkylsulphonyl each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 6 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or phenyl which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 6 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms,

R^2 represents hydroxyl, cyano or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphonyl, each of which has up to 8 carbon atoms in the individual alkyl or alkenyl or alkinyl moieties and each of these radicals optionally being monosubstituted or polysubstituted by identical or different substituents, suitable substituents in each case being:

fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1

to 8 carbon atoms, or aryl having 6 to 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 5 hetero atoms (in particular nitrogen, oxygen and/or sulphur), these aryl or heteroaryl substituents in each case optionally being monosubstituted or polysubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 8 carbon atoms, straight-chain or branched alkenyl having 2 to 8 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 8 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 8 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 8 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxythiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 8 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 6 carbon atoms in the alkanediyl moiety, arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and 1 to 8 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents aryl, arylcarbonyl, aryloxycarbonyl, arylcarbonyloxy or

arylaminocarbonylaminocarbonyloxy, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylaminocarbonylaminocarbonyloxy, each of which has 2 to 9 carbon atoms and 1 to 5 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the aryl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, iodine or a straight-chain or branched, in each case optionally unsubstituted or substituted, radical from the series consisting of cycloalkyl, alkyl, alkenyl, alkinyl, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy, alkenyloxy, alkoxy, alkenyloxy, each of which has up to 8 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties, suitable substituents in each case being: fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1 to 8 carbon atoms, or aryl having 6 to 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 5 hetero atoms (in particular nitrogen, oxygen and/or sulphur) , each of these aryl or heteroaryl radicals optionally being monosubstituted or polysubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 8 carbon atoms, straight-chain or branched alkenyl having 2 to 8 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 8 carbon atoms, carbamoyl, thiocarbamoyl

or sulphamoyl, each of which is monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 8 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 8 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 8 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 6 carbon atoms in the alkanediyl moiety, arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and 1 to 8 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^3 furthermore represents aryl having in each case 6 to 10 carbon atoms in the aryl moiety which is in each case optionally monosubstituted or polysubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3), and

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, fluorine, chlorine, bromine, iodine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 8 carbon atoms, cycloalkyl having 3 to 8 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 6 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 8 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or polysubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 6 carbon atoms, halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each

case being those mentioned in the case of R^1, and

where at least one of the substituents X^1, X^2 or X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogeno-alkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 6 carbon atoms and 1 to 13 identical or different halogen atoms, or represents straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, or divalent dioxyalkylene having 1 to 5 carbon atoms which is optionally monosubstituted or polysubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 6 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 8 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstitued or polysubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 6 carbon atoms, halogenoalkyl having 1 to 6 carbon atoms and 1 to 13 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 6 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted by identical or different substituents in the aryl moiety, suitable aryl substituents in each case being those mentioned in the case of R^1,

X^1, X^2 and X^3 furthermore represent aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 to 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted or polysubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being

those mentioned in the case of R^1.

Particularly preferred compounds of the formula (I) are those in which

R^1 represents hydrogen, or a straight-chain or branched radical from the series consisting of alkyl and alkoxy, each of which has 1 to 6 carbon atoms and each of which is unsubstituted or substituted, or represents phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable substituents being:

fluorine, chlorine, bromine, iodine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 4 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl or halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, or phenyl which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, halogen in each case representing fluorine, chlorine, bromine or iodine,

R^2 represents hydroxyl, cyano, or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy and dialkoxyphosphonyl, each of which has up to 6 carbon atoms in the individual

alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of fluorine, chlorine, bromine and iodine, or represents alkyl, alkenyl or alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphonyl, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 6 carbon atoms, or aryl having 6 or 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 4 hetero atoms (in particular nitrogen, oxygen and/or sulphur), each of these aryl or heteroaryl radicals optionally being monosubstituted to trisubstituted by identical or different substituents and suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 6 carbon atoms, straight-chain or branched alkenyl having 2 to 6 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 6 carbon atoms, or cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 7 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 6 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 5 carbon atoms in the alkanediyl moiety, arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 or 10 carbon

atoms in the aryl moiety and 1 to 6 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents aryl, arylcarbonyl, aryloxycarbonyl, arylcarbonyloxy or arylaminocarbonylaminocarbonyloxy, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned under R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylaminocarbonylaminocarbonyloxy, each of which has 2 to 9 carbon atoms and 1 to 4 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted to pentasubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the aryl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, iodine, or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl and alkylcarbonyloxy, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and which is optionally monosubstituted to pentasubstituted by identical or different substituents from the series consisting of fluorine, chlorine, bromine and iodine, or represents cycloalkyl, alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphonyl, each of which has up to 6 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different

substituents, suitable substituents in each case being:

fluorine, chlorine, bromine, iodine, straight-chain or branched alkoxy having 1 to 6 carbon atoms, or aryl having 6 or 10 carbon atoms or heteroaryl having 2 to 9 carbon atoms and 1 to 4 hetero atoms (in particular nitrogen, oxygen and/or sulphur) , each of these aryl or heteroaryl radicals optionally being monosubstituted to trisubstituted by identical or different substituents, suitable aryl or heteroaryl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 6 carbon atoms, straight-chain or branched alkenyl having 2 to 6 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 6 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 6 carbon atoms, or cycloalkyl, cycloalkylcarbonyl, or cycloalkyloxycarbonyl, each of which has 3 to 7 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 6 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 5 carbon atoms in the alkanediyl moiety, or arylalkyl, arylalkylcarbonyl or arylalkyloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and 1 to 6 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted to trisubstituted by identical or different substituents in the aryl moiety, or aryl, arylcarbonyl or aryloxycarbonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to trisubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

R^3 furthermore represents aryl having in each case 6 or 10 carbon atoms in the aryl moiety which is in each case optionally monosubstituted to pentasubstituted by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3), and

X^1, X^2 and X^3 in each case independently of one another represent hydrogen, fluorine, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 6 carbon atoms, cycloalkyl having 3 to 7 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, or divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 4 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 7 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 4 carbon atoms, halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl, arylaminocarbonyl or arylmethylsulphonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, aryloxy, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1, and

where at least one of the substituents X^1, X^2 and X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, or divalent dioxyalkylene having 1 to 4 carbon atoms which is optionally monosubstituted to hexasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 4 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 4 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3 to 7 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 4 carbon atoms, halogenoalkyl having 1 to 4 carbon atoms and 1 to 9 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 4 carbon atoms in the individual alkyl moieties, or arylcarbonyl, arylsulphonyl arylaminocarbonyl, or arylmethylsulphonyl, each of which has 6 or 10 carbon atoms in the aryl moiety and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent aryl, arylthio, arylsulphinyl, arylsulphonyl, arylsulphonyloxy, arylcarbonyl, aryloxycarbonyl, arylthiomethylsulphonyl or arylazo, each of which has 6 or 10 carbon atoms in the aryl moiety, such as phenyl or naphthyl, and each of which is optionally monosubstituted to pentasubstituted in the aryl moiety by identical or different substituents, suitable aryl substituents in each case being those mentioned in the case of R^1.

Very particularly preferred compounds of the formula (I) are those in which

R^1 represents hydrogen or a straight-chain or branched radical from the series consisting of alkyl and alkoxy, each of which has 1 to 4 carbon atoms and each of which is unsubstituted or substituted, or represents phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents being:

fluorine, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 3 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl or halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, in each case straight-chain or branched alkoxyalkyl, alkoxyalkoxy, alkanoyl, alkoxycarbonyl or alkoximinoalkyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to

tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, halogen in each case representing fluorine, chlorine or bromine,

R^2 represents hydroxyl, cyano or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy and dialkoxyphosphonyl, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of fluorine, chlorine and bromine, or represents alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphoryl, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties, and each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 3 carbon atoms or phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable phenyl substituents being those mentioned in the case of R^1,

R^2 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 4 carbon atoms,

straight-chain or branched alkenyl having 2 to 4 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, carbamoyl, thiocarbamoyl or sulphamoyl, each of which is optionally monosubstituted or disubstituted by identical or different straight-chain or branched alkyl substituents having 1 to 4 carbon atoms, cycloalkyl, cycloalkylcarbonyl or cycloalkyloxycarbonyl, each of which has 3 to 6 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 4 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of which has 2 to 4 carbon atoms in the alkanediyl moiety, phenylalkyl, phenylalkylcarbonyl or phenylalkyloxycarbonyl, each of which has 1 to 4 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, or phenyl, phenylcarbonyl or phenyloxycarbonyl, each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents phenyl, phenylcarbonyl, phenyloxycarbonyl, phenylcarbonyloxy or phenylaminocarbonylaminocarbonyloxy, each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

R^2 furthermore represents heteroaryl, heteroarylcarbonyl, heteroaryloxycarbonyl, heteroarylcarbonyloxy or heteroarylaminocarbonylaminocarbonyloxy, each of which have 2 to 9 carbon atoms and 1 to 3 identical or different hetero atoms (in particular nitrogen, oxygen and/or sulphur) in the heteroaryl moiety and each of which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable heteroaryl substituents in each case being the phenyl substituents mentioned in the case of R^1,

R^3 represents cyano, fluorine, chlorine, bromine, or a straight-chain or branched radical from the series consisting of alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl and alkylcarbonyloxy, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted to trisubstituted by identical or different substituents from the series consisting of fluorine, chlorine and bromine, or represents alkyl, alkenyl, alkinyl, alkoxy, alkenyloxy, alkinyloxy, alkylthio, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or dialkoxyphosphoryl, each of which has up to 4 carbon atoms in the individual alkyl, alkenyl or alkinyl moieties and each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

straight-chain or branched alkoxy having 1 to 3 carbon atoms or phenyl which is optionally monosubstituted or disubstituted by identical or different substituents, suitable phenyl substituents being those mentioned in the case of R^1,

R^3 furthermore represents amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable substituents in each case being:

formyl, straight-chain or branched alkyl having 1 to 4 carbon atoms, straight-chain or branched alkenyl having 2 to 4 carbon atoms, straight-chain or branched alkylsulphonyl having 1 to 4 carbon atoms, in each case optionally monosubstituted or disubstituted (identically or differently by straight-chain or branched alkyl having 1 to 4 carbon atoms) carbamoyl, thiocarbamoyl or sulphamoyl, cycloalkyl, cycloalkylcarbonyl, or cycloalkyloxycarbonyl, each of which has 3 to 6 carbon atoms in the cycloalkyl moiety, alkylcarbonyl, alkenylcarbonyl, alkoxycarbonyl, alkenyloxycarbonyl, alkylthio-carbonyl, alkoxy-thiocarbonyl or alkylthio-thiocarbonyl, each of which has 1 to 4 carbon atoms in the individual straight-chain or branched alkyl moieties, in each case divalent and cyclized alkanediylcarbonyl or alkanediyloxycarbonyl, each of

which has 2 to 4 carbon atoms in the alkanediyl moiety, phenylalkyl, phenylalkylcarbonyl or phenylalkyloxycarbonyl, each of which has 1 to 4 carbon atoms in the straight-chain or branched alkyl moiety and each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, or phenyl, phenylcarbonyl or phenyloxycarbonyl, each of which is optionally monosubstituted or disubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

R^3 furthermore represents phenyl which is optionally monosubstituted to trisubstituted by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1,

A^1, A^2, A^3 and A^4 in each case represent N(nitrogen), N-CHR^1R^2 or CX, the hetero-fused ring having at least one, but not more than two, nitrogen atoms simultaneously and all positional isomers being possible, so that

CX^1, CX^2, CX^3 exist in the case of one nitrogen atom and

CX^1 and CX^2 exist in the case of two nitrogen atoms, and, when either A^1, A^2, A^3 or A^4 represent N-CHR^1R^2, the imidazole ring exists only in monosubstituted form (R^3), and

X^1, X^2 and X^3 independently of one another in each case represent hydrogen, chlorine, bromine, cyano, nitro, in each case straight-chain or branched alkyl, alkoxy, alkylthio, alkylsulphinyl or alkylsulphonyl, each of which has 1 to 4 carbon atoms, cycloalkyl having 3, 5 or 6 carbon atoms, in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogeno-alkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or represent divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched alkyl having 1 to 3 carbon

atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, furthermore represent hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 3 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3, 5 or 6 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 3 carbon atoms, halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, or phenylcarbonyl, phenylsulphonyl, phenylaminocarbonyl or phenylmethylsulphonyl, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent phenyl, phenyloxy, phenylthio, phenylsulphinyl, phenylsulphonyl, phenylsulphonyloxy, phenylcarbonyl, phenyloxycarbonyl, phenylthiomethylsulphonyl or phenylazo, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1, and

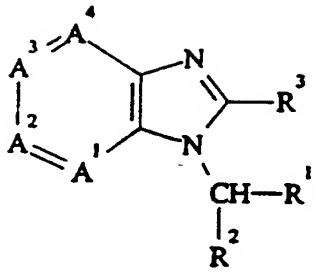
where at least one of the substituents X^1, X^2 and X^3 represents in each case straight-chain or branched halogenoalkyl, halogenoalkoxy, halogenoalkylthio, halogenoalkylsulphinyl, halogenoalkylsulphonyl, each of which has 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, or represents straight-chain or branched alkylsulphonyl having 1 to 3 carbon atoms, or represents divalent dioxyalkylene having 1 to 3 carbon atoms which is optionally monosubstituted to tetrasubstituted by identical or different substituents from the series consisting of halogen, straight-chain or branched

alkyl having 1 to 3 carbon atoms and straight-chain or branched halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 identical or different halogen atoms, furthermore represents hydroxycarbonyl, in each case straight-chain or branched alkylcarbonyl or alkoxycarbonyl, each of which has 1 to 3 carbon atoms in the alkyl moiety, cycloalkyloxycarbonyl having 3, 5 or 6 carbon atoms in the cycloalkyl moiety, or amino or aminocarbonyl, each of which is optionally monosubstituted or disubstituted by identical or different substituents, suitable amino substituents in each case being:

in each case straight-chain or branched alkyl having 1 to 3 carbon atoms, halogenoalkyl having 1 to 3 carbon atoms and 1 to 7 halogen atoms, alkoxyalkyl or alkylcarbonyl, each of which has 1 to 3 carbon atoms in the individual alkyl moieties, or phenylcarbonyl, phenylsulphonyl, phenylaminocarbonyl or phenylmethylsulphonyl, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1;

X^1, X^2 and X^3 furthermore represent phenyl, phenylthio, phenylsulphinyl, phenylsulphonyl, phenylsulphonyloxy, phenylcarbonyl, phenyloxycarbonyl, phenylthiomethylsulphonyl or phenylazo, each of which is optionally monosubstituted to trisubstituted in the phenyl moiety by identical or different substituents, suitable phenyl substituents in each case being those mentioned in the case of R^1.

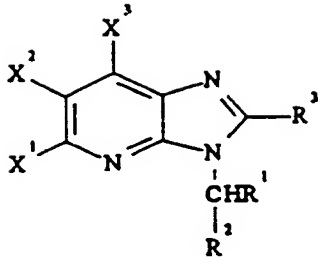
Substituted hetero-fused imidazoles of the general formula (I)

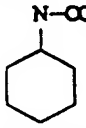


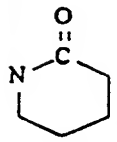
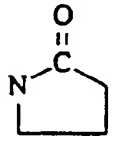
(I)

which may be mentioned individually in addition to the compounds mentioned in the preparation examples are those which follow:

Table I

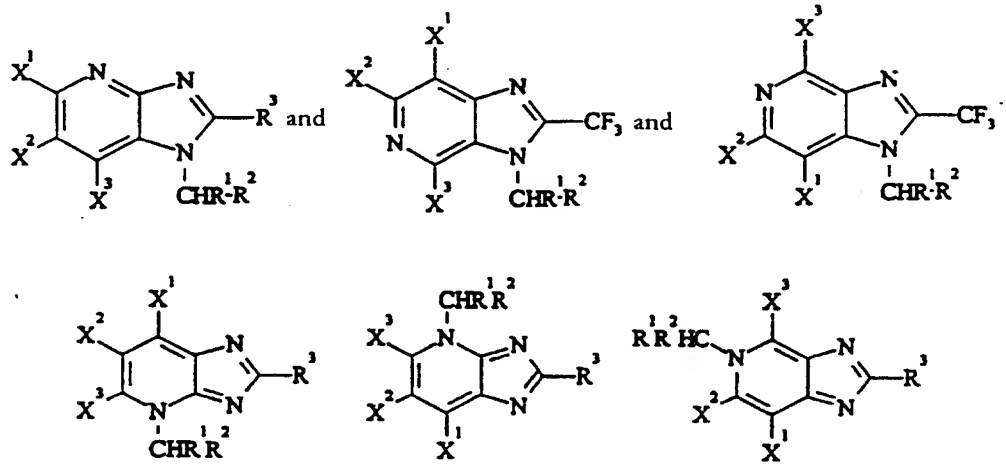


X^1	X^2	X^3	R^1	R^2	R^3
H	H	H	H	OEt	CF_3
H	H	H	H	OPr	CF_3
H	H	H	H	OCH=CH	CF_3
H	H	H	H	OiPr	CF_3
H	H	H	H	OnBu	CF_3
H	H	H	H	OiBu	CF_3
H	H	H	H	OtBu	CF_3
H	H	H	H	Osec.Bu	CF_3
H	H	H	H	OCH_2CH_2OMe	CF_3
H	H	H	H	OCH_2CH_2OEt	CF_3
H	H	H	H	N(COOEt)-Me	CF_3
H	H	H	H	N(COOEt)-Et	CF_3
H	H	H	H	N(COOEt)-Pr	CF_3
H	H	H	H		CF_3
H	H	H	H	N(COOEt)-tBu	CF_3
H	H	H	H	N(COOEt)-nPr	CF_3
H	H	H	H	N(COOEt)-iPr	CF_3
H	H	H	H	N(COOEt)- 	CF_3

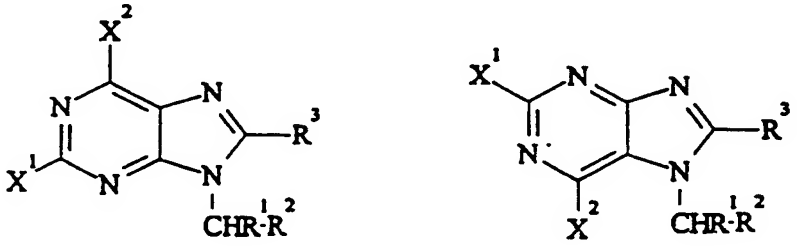
X^1	X^2	X^3	R^1	R^2	R^3
H	H	H	H		CF_3
H	H	H	H		CF_3
H	Br	H	H		
Br	H	H	H		
H	Br	H	H		
H	Cl	H	H		
Cl	H	H	H		
H	H	Cl	H		
F	H	H	H		
H	F	H	H		
H	H	F	H		
H	CF_3	H	H		
CF_3	H	H	H		
H	H	CF_3	H		
H	OCF_3	H	H		
H	SCF_3	H	H		
H	NO_2	H	H		
H	CHF_2	H	H		
H	$OCHF_2$	H	H		
H	H	H	H	$CH=CH_2$	CF_3
H	H	H	H	$C\equiv CH$	CF_3
H	H	H	H	$COCH_3$	CF_3
H	H	H	H	H_3CCONH-	CF_3
H	H	H	H	$(H_3)_2CCONH$-	CF_3

All the examples also apply to $R^3 = CHF_2$, $R^3 = C_2F_5$, $R^3 = C_3F_7$, and, additionally, the R^2 and R^3 radicals can be varied, as shown in the Table, for each X^1 to X^3 pattern.

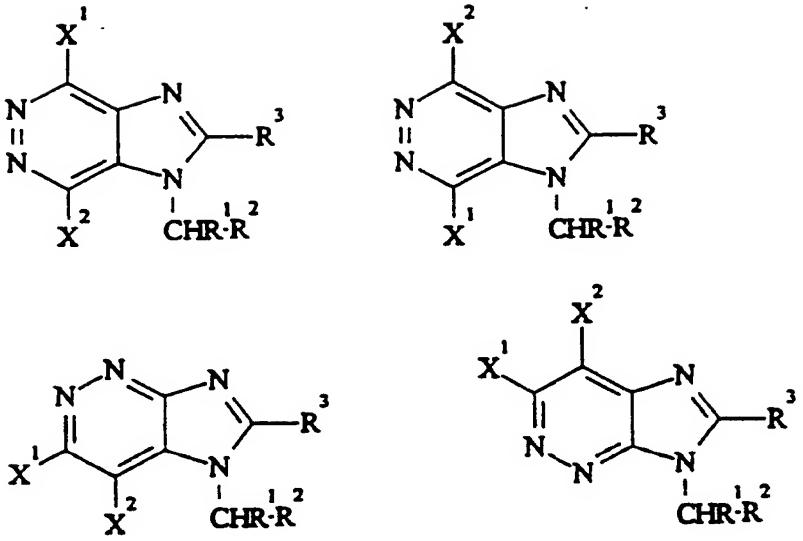
The substituent variations shown in the above table can also be given for the other isomeric pyridines:



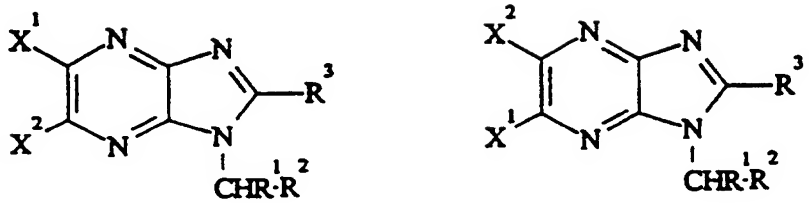
This variation, limited to X^1 and X^2, also applies analogously to the pyrimidinoimidazoles



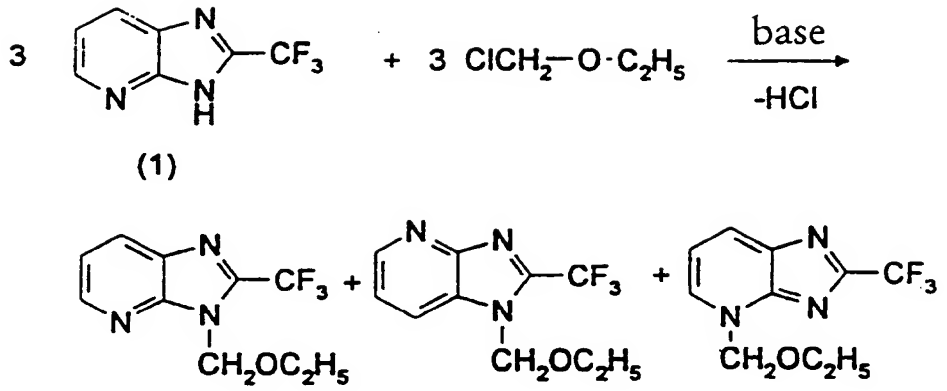
the pyridazines



and the pyrazines



If, for example, the pyrimidinoimidazole (1) and chloromethyl ethyl ester are used as starting compounds, the course of the reaction of the process according to the invention can be represented by the following equation:



Formula (II) provides a general definition of the hetero-fused imidazoles required as starting materials for carrying out the process according to the invention. In this formula (II), A^1, A^2, A^3, A^4 and R^3 preferably represent those radicals which have already been mentioned in connection with the description of the compound of the formula (I) according to the invention as being preferred for these substituents.

The 1H-hetero-fused imidazoles of the formula (II) are known or can be obtained in analogy to known processes (GB 1 114 199; JP 62 294 683; J. Heterocyl. Chem. 18 (2), 303-7; EP 297 661; J. Med. Chem. 33 (8), 2231-9).

Formula (III) provides a general definition of the compounds furthermore required as educts for carrying out the process according to the invention. In this formula (III), R^1 and R^2 preferably represent those radicals which have already been mentioned in connection with the substances of the formula (I) according to the invention as being preferred for the substituents.

M represents a leaving radical customary in alkylating agents, preferably halogen, arylsulphonate, arylalkylsuphonate, alkylsulphonate, alkylcarbonyloxy or arylcarbonyloxy, particularly preferably chlorine, bromine, iodine, C_{1-8}-alkylsulphonate, tolylsulphonate, phenylsulphonate, C_{1-8}-alkylcarbonyloxy, or benzoyl, and particularly preferably chlorine, bromine, C_1-C_2-alkylsulphonate, phenylsulphonate, tolylsulphonate, C_1-C_3-alkylcarbonyloxy or benzoyl.

The compounds of the formula (III) are known or can be obtained in analogy to known processes (cf., for example, DE 20 40 175; DE 21 19 518; Synthesis 1973, 703).

Suitable diluents for carrying out the process according to the invention are inert organic solvents. These include, in particular, aliphatic, alicyclic or aromatic, optionally halogenated hydrocarbons, such as, for example, benzine, benzene, toluene, xylene, chlorobenzene, dichlorobenzene, petroleum ether, hexane, cyclohexane, dichloromethane, chloroform or carbon tetrachloride; ethers, such as diethyl ether, diisopropyl ether, dioxane, tetrahydrofuran, ethylene glycol dimethyl ether or ethylene glycol diethyl ether; ketones, such as acetone, butanone or methyl isobutyl ketone; nitriles, such as acetonitrile, propionitrile or benzonitrile; amides, such as N,N-dimethylformamide, N,N-dimethylacetamide, N-methylformanilide N-methyl-pyrrolidone or hexamethylphosphoric triamide; esters, such as methyl acetate or ethyl acetate, or bases such as pyridine, or organic acids such as formic acid or acetic acid.

The process according to the invention is preferably carried out in the presence of a suitable reaction auxiliary. Suitable reaction auxiliaries are all customary inorganic or organic bases. These include, for example, the hydrides, hydroxides, amides, alcoholates, acetates, carbonates or hydrogen carbonates of alkaline earth metals or alkali metals, such as, for example, sodium hydride, sodium amide, lithium diethylamide, sodium methylate, sodium ethylate, potassium tert-butylate, sodium hydroxide, potassium hydroxide, ammonium hydroxide, sodium acetate, potassium acetate, calcium acetate, ammonium acetate, sodium carbonate, potassium carbonate, potassium hydrogen carbonate, sodium hydrogen carbonate or ammonium carbonate, organolithium compounds, such as n-butyllithium, and also tertiary amines, such as trimethylamine, triethylamine, tributylamine, di-isopropyl-ethylamine, tetramethylguanidine, N,N-dimethylaniline, pyridine, piperidine, N-methylpiperidine, N,N-dimethylaminopyridine, diazabicyclooctane (DABCO), diazabicyclononene (DBN) or diazabicycloundecene (DBU).

In those cases where A in formula (III) represents an alcohol, alkanoyloxy or alkoxy group, suitable reaction auxiliaries also include organic or inorganic acids, such as, for example, sulphuric acid, hydrochloric acid, p-toluenesulphonic acid,

perfluorobutanesulphonic acid or strongly acidic ion exchangers.

If appropriate, the process according to the invention can also be carried out in a two-phase system, such as, for example, water/toluene or water/dichloromethane, if appropriate in the presence of a suitable phase transfer catalyst. Examples of such catalysts which may be mentioned are: tetrabutylammonium iodide, tetrabutylammonium bromide, tetrabutylammonium chloride, tributyl-methylphosphonium bromide, trimethyl-C_{13}/C_{15}-alkylammonium chloride, trimethyl-C_{13}/C_{15}-alkylammonium bromide, dibenzyl-dimethyl-ammonium methylsulphate, dimethyl-C_{12}/C_{14}-alkylbenzylammonium chloride, dimethyl-C_{12}/C_{14}-alkylbenzylammonium bromide, tetrabutylammonium hydroxide, triethylbenzylammonium chloride, methyltrioctylammonium chloride, trimethylbenzylammonium chloride, 15-krone-5, 18-krone-6 or tris-[2-(2-methoxyethoxy)-ethyl]-amine.

When carrying out the process according to the invention, the reaction temperatures can be varied within a substantial range. In general, the process is carried out at temperatures between -70°C and +200°C, preferably at temperatures between 0°C and 130°C.

The process according to the invention is conventionally carried out under atmospheric pressure. However, it can also be carried out under elevated or reduced pressure.

To carry out the process according to the invention, 1.0 to 5.0 mol, preferably 1.0 to 2.5 mol, of the compound of the formula (III) and, if appropriate, 0.01 to 5.0 mol, preferably 1.0 to 3.0 mol, of reaction auxiliary are generally employed per mole of 1H-hetero-fused imidazole of the formula (II).

In a particular embodiment, it is also possible to first silylate the 1H-hetero-fused imidazoles of the formula (II) in a preceding reaction step with the aid of customary silylation methods, for example with hexamethyldisilazane or trimethylsilyl chloride, at temperatures between -20°C and +50°C, if appropriate in the presence of a suitable catalyst, such as, for example, sulphuric acid, trifluoroacetic acid, ammonium sulphate, imidazole or saccharin, and to react the resulting hetero-fused

1-trimethylsilylimidazoles in a subsequent second step with alkylating agents of the formula (II) in accordance with the process according to the invention. In this case, it is advantageous to add tin tetrachloride as a catalyst for the alkylation reaction (cf., for example, Chem. Heterocycl. Comp. USSR 24, 514 [1988])

The reaction is carried out and the reaction products are worked up and isolated by known methods (cf. in this context also the preparation examples).

The end products of the formula (I) are purified with the aid of customary processes, for example by column chromatography or by recrystallization.

They are characterized with the aid of the melting point or, in the case of compounds which do not crystallize - in particular in the case of regio isomer mixtures - , with the aid of proton nuclear resonance spectroscopy (^{1}H NMR).

The active compounds according to the invention are suitable for combating animal pests, preferably arthropods and nematodes, in particular insects and arachnida, which are encountered in agriculture, in forestry, in the protection of stored products and of materials, and in the hygiene field. They are active against normally sensitive and resistant species and against all or some stages of development. The abovementioned pests include:

From the order of the Isopoda, for example, Oniscus asellus, Armadillidium vulgare and Porcellio scaber.

From the order of the Diplopoda, for example, Blaniulus guttulatus

From the order of the Chilopoda, for example, Geophilus carpophagus and Scutigera spec.

From the order of the Symphyla, for example, Scutigerella immaculata.

From the order of the Thysanura, for example, Lepisma saccharina.

From the order of the Collembola, for example, Onychiurus armatus.

From the order of the Orthoptera, for example, Blatta orientalis, Periplaneta americana, Leucophaea maderae, Blattella germanica, Acheta domesticus, Gryllotalpa spp., Locusta

migratoria migratorioides, Melanoplus differentialis and Schistocerca gregaria.

From the order of the Dermaptera, for example, Forficula auricularia.
From the order of the Isoptera, for example, Reticulitermes spp..
From the order of the Anoplura, for example, Phylloxera vastatrix, Pemphigus spp., Pediculus humanus corporis, Haematopinus spp. and Linognathus spp..
From the order of the Mallophaga, for example, Trichodectes spp. and Damalinea spp.
From the order of the Thysanoptera, for example, Hercinothrips femoralis and Thrips tabaci.

From the order of the Heteroptera, for example, Eurygaster spp., Dysdercus intermedius, Piesma quadrata, Cimex lectularius, Rhodnius prolixus and Triatoma spp.

From the order of the Homoptera, for example, Aleurodes brassicae, Bemisia tabaci, Trialeurodes vaporariorum, Aphis gossypii, Brevicoryne brassicae, Cryptomyzus ribis, Aphis fabae, Doralis pomi, Eriosoma lanigerum, Hyalopterus arundinis, Macrosiphum avenae, Myzus spp., Phorodon humuli, Rhopalosiphum padi, Empoasca spp., Euscelis bilobatus, Nephotettix cincticeps, Lecanium corni, Saissetia oleae, Laodelphax striatellus, Nilaparvata lugens, Aonidiella aurantii, Aspidiotus hederae, Pseudococcus spp. and Psylla spp.

From the order of the Lepidoptera, for example, Pectinophora gossypiella, Bupalus piniarius, Cheimatobia brumata, Lithocolletis blancardella, Hyponomeuta padella, Plutella maculipennis, Malacosoma neustria, Euproctis chrysorrhoea, Lymantria spp. Bucculatrix thurberiella, Phyllocnistis citrella, Agrotis spp., Euxoa spp., Feltia spp., Earias insulana, Heliothis spp., Spodoptera exigua, Mamestra brassicae, Panolis flammea, Prodenia litura, Spodoptera spp., Trichoplusia ni, Carpocapsa pomonella, Pieris spp., Chilo spp., Pyrausta nubilalis, Ephestia kuehniella, Galleria mellonella, Tineola bisselliella, Tinea pellionella, Hofmannophila pseudospretella, Cacoecia podana, Capua reticulana, Choristoneura fumiferana, Clysia ambiguella, Homona magnanima and Tortrix viridana.

From the order of the Coleoptera, for example, Anobium punctatum, Rhizopertha

dominica, Acanthoscelides obtectus, Acanthoscelides obtectus, Hylotrupes bajulus, Agelastica alni, Leptinotarsa decemlineata, Phaedon cochleariae, Diabrotica spp., Psylliodes chrysocephala, Epilachna varive stis, Atomaria spp., Oryzaephilus surinamensis, Antho nomus spp., Sitophilus spp., Otiorrhynchus sulcatus, Cosmopolites sordidus, Ceuthorrhynchus assimilis, Hypera postica, Dermestes spp., Trogoderma spp., Anthrenus spp., Attagenus spp., Lyctus spp., Meligethes aeneus, Ptinus spp., Niptus hololeucus, Gibbium psylloides, Tribolium spp., Tenebrio molitor, Agriotes spp., Cono derus spp., Melolontha melolontha, Amphimallon solsti tialis and Costelytra zealandica.

From the order of the Hymenoptera, for example, Diprion spp., Hoplocampa spp., Lasius spp., Monomorium pharaonis and Vespa spp.

From the order of the Diptera, for example, Aedes spp., Anopheles spp., Culex spp., Drosophila melanogaster, Musca spp., Fannia spp., Calliphora erythrocephala, Lucilia spp., Chrysomyia spp., Cuterebra spp., Gastrophilus spp., Hyppobosca spp., Stomoxys spp., Oestrus spp., Hypoderma spp., Tabanus spp., Tannia spp., Bibio hortulanus, Oscinella frit, Phorbia spp., Pegomyia hyoscyami, Ceratitis capitata, Dacus oleae and Tipula paludosa.

From the order of the Siphonaptera, for example, Xenopsylla cheopis and Ceratophyllus spp..

From the order of the Arachnida, for example, Scorpio maurus and Latrodectus mactans.

From the order of the Acarina, for example, Acarus siro, Argas spp., Ornithodoros spp., Dermanyssus gallinae, Eriophyes ribis, Phyllocoptruta oleivora, Boophilus spp., Rhipicephalus spp., Amblyomma spp., Hyalomma spp., Ixodes spp., Psoroptes spp., Chorioptes spp., Sarcoptes spp., Tarsonemus spp., Bryobia praetiosa, Panonychus spp. and Tetranychus spp..

The active compounds according to the invention are distinguished by a powerful insecticidal and acaricidal activity.

They can be employed particularly successfully for combating plant-injurious insects, such as, for example, against the larvae of the mustard beetle (Phaedon cochleariae) or against the larvae of the green rice leafhopper (Nephotettix cincticeps) against the caterpillars of the diamond-back moth Plutella maculipennis.

The active compounds according to the invention can be furthermore used as defoliants, agents for destroying broad-leaved plants and, especially, as weed-killers. By weeds, in the broadest sense, there are to be understood all plants which grow in locations where they are undesired. Whether the substances according to the invention act as total or selective herbicides depends essentially on the amount used.

The active compounds according to the invention can be used, for example, in connection with the following plants:

Dicotyledon weeds of the genera: Sinapis, Lepidium, Galium, Stellaria, Matricaria, Anthemis, Galinsoga, Chenopodium, Urtica, Senecio, Amaranthus, Portulaca, Xanthium, Convolvulus, Ipomoea, Polygonum, Sesbania, Ambrosia, Cirsium, Carduus, Sonchus, Solanum, Rorippa, Rotala, Lindernia, Lamium, Veronica, Abutilon, Emex, Datura, Viola, Galeopsis, Papaver and Centaurea.

Dicotyledon cultures of the genera: Gossypium, Glycine, Beta, Daucus, Phaseolus, Pisum, Solanum, Linum, Ipomoea, Vicia, Nicotiana, Lycopersicon, Arachis, Brassica, Lactuca, Cucumis and Cucurbita.

Monocotyledon weeds of the genera: Echinochloa, Setaria, Panicum, Digitaria, Phleum, Poa, Festuca, Eleusine, Brachiaria, Lolium, Bromus, Avena, Cyperus, Sorghum, Agropyron, Cynodon, Monochoria, Fimbristylis, Sagittaria, Eleocharis, Scirpus, Paspalum, Ischaemum, Sphenoclea, Dactyloctenium, Agrostis, Alopecurus and Apera.

Monocotyledon cultures of the genera: Oryza, Zea, Triticum, Hordeum, Avena, Secale, Sorghum, Panicum, Saccharum, Ananas, Asparagus and Allium.

However, the use of the active compounds according to the invention is in no way restricted to these genera, but also extends in the same manner to other plants.

The compounds are suitable, depending on the concentration, for the total combating of weeds, for example on industrial terrain and rail tracks, and on paths and squares with or without tree plantings. Equally, the compounds can be employed for combating weeds in perennial cultures, for example afforestations, decorative tree plantings, orchards, vineyards, citrus groves, nut orchards, banana plantations, coffee plantations, tea plantations, rubber plantations, oil palm plantations, cocoa plantations, soft fruit plantings and hopfields, and for the selective combating of weeds in annual cultures.

The active compounds according to the invention can be employed particularly successfully for combatting monocotyledon and dicotyledon weeds in monocotyledon and dicotyledon cultures, such as, for example, wheat, maize or soya beans.

The active compounds can be converted into the customary formulations, such as solutions, emulsions, suspensions, powders, foams, pastes, granules, aerosols, natural and synthetic materials impregnated with active compound, and very fine capsules in polymeric substances.

These formulations are produced in a known manner, for example by mixing the active compounds with extenders, that is liquid solvents, liquified gases under pressure and/or solid carriers, optionally with the use of surface-active agents, that is emulsifying agents and/or dispersing agents and/or foam-forming agents.

In the case of the use of water as an extender, organic solvents can, for example, also be used as auxiliary solvents. As liquid solvents, there are suitable in the main: aromatics, such as xylene, toluene or alkylnaphthalenes, chlorinated aromatics and chlorinated aliphatic hydrocarbons, such as chlorobenzenes, chloroethylenes or methylene chloride, aliphatic hydrocarbons, such as cyclohexane or paraffins, for example petroleum fractions, mineral and vegetable oils, alcohols, such as butanol or glycol as well as their ethers and esters, ketones, such as acetone, methyl ethyl ketone, methyl isobutyl ketone or cyclohexanone, strongly polar solvents, such as

dimethylformamide and dimethyl sulphoxide, as well as water.

As solid carriers there are suitable: for example ammonium salts and ground natural minerals, such as kaolins, clays, talc, chalk, quartz, attapulgite, montmorillonite or diatomaceous earth, and ground synthetic minerals, such as highly disperse silica, alumina and silicates; as solid carriers for granules there are suitable: for example crushed and fractionated natural rocks such as calcite, marble, pumice, sepiolite and dolomite, as well as synthetic granules of inorganic and organic meals, and granules of organic material such as sawdust, coconut shells, maize cobs and tobacco stalks; as emulsifying and/or foam forming agents there are suitable: for example non-ionic and anionic emulsifiers, such as polyoxyethylene fatty acid esters, polyoxyethylene fatty alcohol ethers, for example alkylaryl polyglycol ethers, alkylsulphonates, alkyl sulphates, arylsulphonates as well as albumen hydrolysis products; as dispersing agents there are suitable: for example lignin-sulphite waste liquors and methylcellulose.

Adhesives such as carboxymethylcellulose and natural and synthetic polymers in the form of powders, granules or latexes, such as gum arabic, polyvinyl alcohol and polyvinyl acetate, as well as natural phospholipids, such as cephalins and lecithins, and synthetic phospholipids, can be used in the formulations. Further additives can be mineral and vegetable oils.

It is possible to use colorants such as inorganic pigments, for example iron oxide, titanium oxide and Prussian Blue, and organic dyestuffs, such as alizarin dyestuffs, azo dyestuffs and metal phthalocyanine dyestuffs, and trace nutrients such as salts of iron, manganese, boron, copper, cobalt, molybdenum and zinc.

The formulations in general contain between 0.1 and 95 per cent by weight of active compound, preferably between 0.5 and 90%.

For combating weeds, the active compounds according to the invention, as such or in the form of their formulations, can also be used as mixtures with known herbicides, finished formulations or tank mixes being possible.

Suitable herbicides for the mixtures are known herbicides, for example anilides such as, for example, diflufenican and propanil; arylcarboxylic acids such as, for example, dichloropicolinic acid, dicamba and picloram; aryloxyalkanoic acids such as, for example, 2,4-D, 2,4-DB, 2,4-DP, fluroxypyr, MCPA, MCPP and triclopyr; aryloxy-phenoxy-alkanoic esters such as, for example, diclofop-methyl, fenoxaprop-ethyl, fluazifop-butyl, haloxyfop-methyl and quizalofop-ethyl; azinones such as, for example, chloridazon and norflurazon; carbamates such as, for example, chlorpropham, desmedipham, phenmedipham and propham; chloroacetanilides such as, for example, alachlor, acetochlor, butachlor, metazachlor, metolachlor, pretilachlor and propachlor; dinitroanilines such as, for example, oryzalin, pendimethalin and trifluralin; diphenyl ethers such as, for example, acifluorfen, bifenox, fluoroglycofen, fomesafen, halosafen, lactofen and oxyfluorfen; ureas such as, for example, chlortoluron, diuron, fluometuron, isoproturon, linuron and methabenzthiazuron; hydroxylamines such as, for example, alloxydim, clethodim, cycloxydim, sethoxydim and tralkoxydim; imidazolinones such as, for example, imazethapyr, imazamethabenz, imazapyr and imazaquin; nitriles such as, for example, bromoxynil, dichlobenil and ioxynil; oxyacetamides such as, for example, mefenacet; sulphonylureas such as, for example, amidosulfuron, bensulfuron-methyl, chlorimuron-ethyl, chlorsulfuron, cinosulfuron, metsulfuron-methyl, nicosulfuron, primisulfuron, pyrazosulfuron-ethyl, thifensulfuron-methyl, triasulfuron and tribenuron-methyl; thiocarbamates such as, for example, butylate, cycloate, di-allate, EPTC, esprocarb, molinate, prosulfocarb, thiobencarb and tri-allate; triazines such as, for example, atrazine, cyanazine, simazine, simetryn, terbutryn and terbutylazine; triazinones such as, for example, hexazinone, metamitron and metribuzin; others such as, for example, aminotriazole, benfuresate, bentazone, cinmethylin, clomazone, clopyralid, difenzoquat, dithiopyr, ethofumesate, fluorochloridone, glufo-sinate, glyphosate, isoxaben, pyridate, quinchlorac, quinmerac, sulphosate and tridiphane.

Mixtures with other known active compounds, such as fungicides, insecticides, acaricides, nematicides, bird repellants, plant nutrients and agents which improve soil structure, are also possible.

The active compounds can be used as such, in the form of their formulations or in the

use forms prepared therefrom by further dilution, such as ready-to-use solutions, suspensions, emulsions, powders, pastes and granules. They are used in the customary manner, for example by watering, spraying, atomizing or scattering.

The active compounds according to the invention can be applied either before or after emergence of the plants.

They can also be incorporated into the soil before sowing.

The amount of active compound used can vary within a substantial range. It depends essentially on the nature of the desired effect. In general, the amounts used are between 0.001 and 10 kg of active compound per hectare of soil surface, preferably between 0.005 and 5 kg per ha.

When the active compounds according to the invention are used as insecticides, they can, again, be present in their commercially available formulations and in the use forms, prepared from these formulations, as a mixture with other active compounds, such as insecticides, attractants, sterilizing agents, acaricides, nematicides, fungicides, growth-regulating substances or herbicides. The insecticides include, for example, phosphates, carbamates, carboxylates, chlorinated hydrocarbons, phenylureas and substances produced by microorganisms.

When the active compounds according to the invention are used as insecticides, they can furthermore be present in their commercially available formulations and in the use forms, prepared from these formulations, as a mixture with synergistic agents. Synergistic agents are compounds which increase the action of the active compounds, without it being necessary for the synergistic agent added to be active itself.

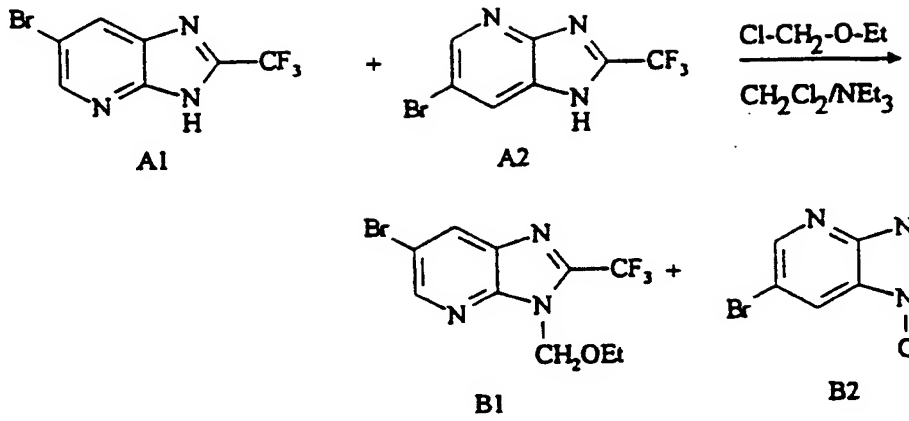
The active compound content of the use forms prepared from the commercially available formulations can vary within wide limits. The active compound concentration of the use forms can be from 0.0000001 to 95 per cent by weight of active compound, preferably between 0.0001 and 1 per cent by weight.

The compounds are employed as insecticides in a customary manner appropriate for the use forms.

Preparation and use of the active compounds according to the invention can be seen from the examples which follow.

Preparation examples

Example 1



2.66 g (0.01 mol) 2-trifluoromethyl-bromo-pyridino-[1H]-imidazole (A1/A2) and 1.75 ml (0.0125 mol) of triethylamine are dissolved in 100 ml of dichloromethane. 1.25 ml (0.0125 mol of chloromethyl methyl ether are added dropwise to this solution, the mixture is subsequently heated at reflux temperature, and stirring is continued for 16 hours at reflux temperature. For working up, the cooled reaction mixture is washed three times using 30 ml of water in each case, dried over $MgSO_4$ and concentrated in vacuo and the residue is purified by chromatography on silica gel (eluent: dichloromethane).

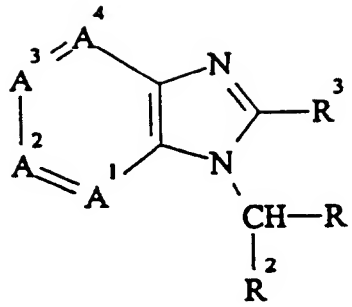
2.40 g (74 % of theory) of 1-ethoxymethyl-2-trifluoromethyl-bromopyridino imidazole are obtained as a regio isomer mixture (B1/B2) in a ratio of 60:40 (m.p.: 68°C).

^1H NMR ($CDCl_3$/tetramethylsilane): δ = 5.68 (s, 2H); 5.85 (s, 2H) ppm (in each case $N-CH_2-O-$).

The isomers can be separated by recrystallization with an ether/petroleum ether mixture.

The compounds listed in the table which follows are obtained analogously.

Table II



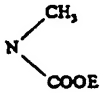
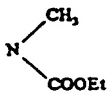
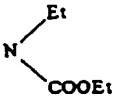
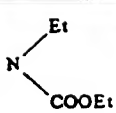
Example No.	A^1	A^2	A^3	A^4	R^1	R^2	R^3	Physical data
2	N	CH	CH	CH	H	OC_2H_5	CF_3	m.p.: 92°C
3	CH	CH	CH	N	H	OC_2H_5	CF_3	m.p.: 170°C
4	CH	N	CH	CH	H	OC_2H_5	CF_3	^{1}H NMR*: 5.89 (s, 2H)
5	CH	CH	N	CH	H	OC_2H_5	CF_3	^{1}H NMR*: 6.08 (s, 2H)
6	N	CH	CBr	CH	H		CF_3	^{1}H NMR*: 5.90 (s, 2H)
7	CH	CBr	CH	N	H		CF_3	^{1}H NMR*: 6.08 (s, 2H)
8	N	CH	CBr	CH	H		CF_3	^{1}H NMR*: 5.90 (s, 2H)
9	CH	CBr	CH	N	H		CF_3	^{1}H NMR*: 6.10 (s, 2H)

Table II (continued)

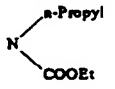
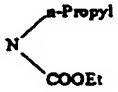
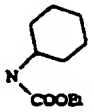
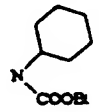
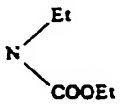
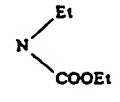
Example No.	A^1	A^2	A^3	A^4	R^1	R^2	R^3	Physical data
10	N	CH	CBr	CH	H		CF_3	^{1}H NMR*: 5.89 (s, 2H)
11	CH	CBr	CH	N	H		CF_3	^{1}H NMR*: 6.09 (s, 2H)
12	N	CH	CBr	CH	H		CF_3	^{1}H NMR*: 5.90 (s, 2H)
13	CH	CBr	CH	N	H		CF_3	^{1}H NMR*: 6.11 (s, 2H)
14	N	CH	CH	CH	H	OC_2H_5	CHF_2	^{1}H NMR*: 5.91 (s, 2H)
15	CH	CH	CH	N	H	OC_2H_5	CHF_2	^{1}H NMR*: 6.14 (s, 2H)
16	CH	N	CH	CH	H		CF_3	^{1}H NMR*: 5.83 (s, 2H) m.p.: 120°C
17	CH	CH	N	CH	H		CF_3	^{1}H NMR*: 6.03 (s, 2H)
18	N	CH	CH	CH	H	$CH=CH_2$	CF_3	^{1}H NMR*: 5.35 (d, J = 3Hz, 2H)

Table II (continued)

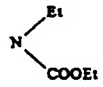
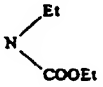
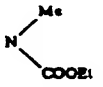
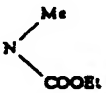
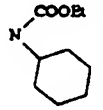
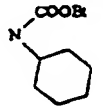
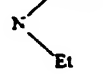
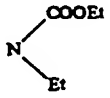
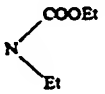
Example No.	A^1	A^2	A^3	A^4	R^1	R^2	R^3	Physical data
19	N	CH	CH	CH	H	$COCH_3$	CF_3	m.p.: 148-150°C
20	N	CH	CH	CH	H	CN	CHF_2	^1H NMR*: 5.48 (s, 2H)
21	N	CH	CH	CH	H		CF_3	^1H NMR*: 5.89 (s, 2H)
22	CH	CH	CH	N	H		CF_3	^1H NMR*: 6.12 (s, 2H)
23	N	CH	CH	CH	H		CF_3	^1H NMR*: 5.94 (s, 2H)
24	CH	CH	CH	N	H		CF_3	^1H NMR*: 6.12 (s, 2H)
25	N	CH	CH	CH	H		CHF_2	^1H NMR*: 5.88 (s, 2H) m.p.: 119°C
26	CH	CH	CH	N	H		CHF_2	^1H NMR*: 6.02 (s, 2H)
27	N	CH	CH	CH	H		CHF_2	^1H NMR*: 5.93 (s, 2H)

Table II (continued)

Example No.	A^1	A^2	A^3	A^4	R^1	R^2	R^3	Physical data
28	CH	CH	CH	N	H		CHF_2	^{1}H NMR*: 6.14 (s, 2H) m.p.: 84°C
29	N	CCl	CH	CH	H		CF_3	^{1}H NMR*: 5.88 (s, 2H)
30	CH	CH	CCl	N	H		CF_3	^{1}H NMR*: 6.02 (s, 2H)
31	N CHR_1 R_2	CH	CH	CH	H	CN	CF_3	m.p.: 184-186°C

* ^{1}H NMR spectra were recorded in deuterochloroform ($CDCl_3$) with tetramethylsilane (TMS) as the internal standard. The data given is the chemical shift as δ-value in ppm; in all cases, the N-$CH_2R^1R^2$ proton shift is given.

Example A:

Pre-emergence test

Solvent: 5 parts by weight of acetone
Emulsifier: 1 part by weight of alkylaryl polyglycol ether

To produce a suitable preparation of active compound, one part by weight of active compound is mixed with the stated amount of solvent, the stated amount of emulsifier is added and the concentrate is diluted with water to the desired concentration.

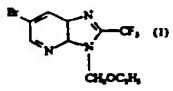
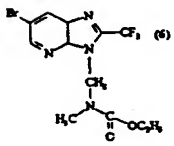
Seeds of the test plants are sown in normal soil and, after 24 hours, watered with the preparation of the active compound. It is expedient to keep constant the amount of water per unit area. The concentration of the active compound in the preparation is of no importance, only the amount of active compound applied per unit area being decisive. After three weeks, the degree of damage to the plants is rated in % damage in comparison to the development of the untreated control. The figures denote:

0% = no action (like untreated control)
100% = total destruction

In this test, a clearly superior activity combined with a similarly good crop plant selectivity is shown by the compounds of Preparation Examples (1) and (6), for example in wheat crops at application rates of 1,000 g per hectare when applied against weeds such as Chenopodium (95-100 %), Galinsoga (95-100 %), Matricaria (90-95 %), Portulaca (100 %), Stellaria (100 %) and Viola (90-95 %), the wheat remaining unharmed (0 %).

Table III

Pre-emergence test/greenhouse

Active comp.	Application rate in g/ha	Wheat	Chenopodium	Galinsoga	Matricaria	Portulaca	Stellaria	Viola
 (1)	1000	0	100	100	95	100	100	95
 (6)	1000	0	95	95	90	100	100	90

Example B:

Post-emergence test

Solvent: 5 parts by weight of acetone
Emulsifier: 1 part by weight of alkylaryl polyglycol ether

To produce a suitable preparation of active compound, one part by weight of active compound is mixed with the stated amount of solvent, the stated amount of emulsifier is added and the concentrate is diluted with water to the desired concentration.

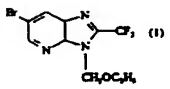
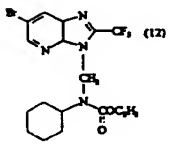
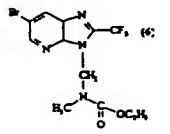
Test plants which have a height of 5 - 15 cm are sprayed with the preparation of the active compound in such a way as to apply the particular amounts of active compound desired per unit area. After three weeks, the degree of damage to the plants is rated in % damage in comparison to the development of the untreated control. The figures denote:

0% = no action (like untreated control)
100% = total destruction

In this test, a clearly superior activity and crop plant selectivity is shown by the compounds of Preparation Examples (1), (6) and (12), for example in wheat crops at application rates of 250 g per hectare when used against weeds such as Datura (90-100 %), Helianthus (90-100 %), Portulaca (90-100 %), Sinapis (100 %) and Solanum (80-100 %), the wheat remaining unharmed (0 %).

Table IV

Post-emergence test/greenhouse

Active compound	Appli-- tion rate in g/ha	Wheat	Datura	Helian- thus	Portu- laca	Sinapis	Solan- um
	250	0	90	90	90	100	80
	250	0	100	100	100	100	100
	250	0	100	100	100	100	100

Example C:

Phaedon larvae test

Solvent: 7 parts by weight of dimethylformamide
Emulsifier: 1 part by weight of alkylaryl polyglycol ether

To produce a suitable preparation of active compond, one part by weight of active compound is mixed with the stated amount of solvent and the stated amount of emulsifier, and the concentrate is diluted with water to the desired concentration.

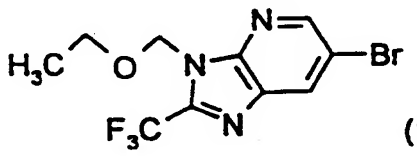
Cabbage leaves (Brassica oleracea) are treated by being dipped into the preparation of active compound of the desired concentration and are infested with mustard beetle larvae (Phaedon cochleariae) while the leaves are still moist.

After the specified periods of time, the destruction in % is determined. 100% means that all the beetle larvae have been killed; 0% means that none of the beetle larvae have been killed.

In this test, for example the compound of Preparation Example (1) shows a degree of destruction of 100 % after 7 days at an active compound concentration 0.1 %.

Table V

Phaedon larvae test
(plant-injurious insects)

Active compounds	Active compound concentration in %	Degree of destruction in % after 7[d]
 (1)	0.1	100

Example D:

Plutella test

Solvent: 5 parts by weight of dimethylformamide
Emulsifier: 1 part by weight of alkylaryl polyglycol ether

To produce a suitable preparation of active compond, one part by weight of active compound is mixed with the stated amount of solvent and the stated amount of emulsifier, and the concentrate is diluted with water to the desired concentration.

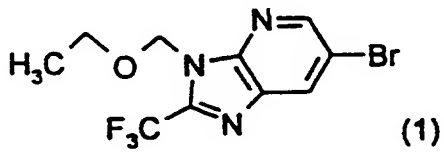
Cabbage leaves (Brassica oleracea) are treated by being dipped into the preparation of active compound of the desired concentration and are infested with caterpillars of the diamond-back moth (Plutella maculipennis) while the leaves are still moist.

After the specified periods of time, the destruction in % is determined. 100% means that all the caterpillars have been killed; 0% means that none of the caterpillars have been killed.

In this test, for example the compound of Preparation Example (1) shows a degree of destruction of 100 % after 7 days at an active compound concentration of 0.1 %.

Table VI

Plutella test
(plant-injurious insects)

Active compounds	Active compound concentration in %	Degree of destruction in % after 7^d
 (1)	0.1	100

Example E:

Nephotettix test

Solvent: 7 parts by weight of dimethylformamide
Emulsifier: 1 part by weight of alkylaryl polyglycol ether

To produce a suitable preparation of active compond, one part by weight of active compound is mixed with the stated amount of solvent and the stated amount of emulsifier, and the concentrate is diluted with water to the desired concentration.

Rice seedlings (Oryza sativa) are treated by being dipped into the preparation of active compound of the desired concentration and are infested with larvae of the green rice leafhopper (Nephotettix cincticeps) while the leaves are still moist.

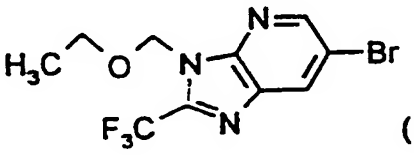
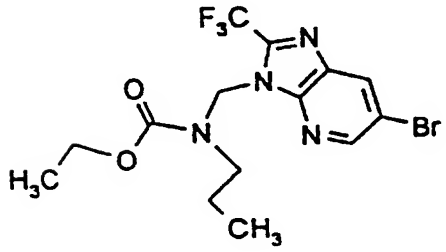
After the specified periods of time, the destruction in % is determined. 100% means that all the leafhoppers have been killed; 0% means that none of the leafhoppers have been killed.

In this test, for example the following compounds of preparation examples (1) and (10) show degrees of destruction of up to 100 % after 6 days at an active compound concentration of 0.1 %.

Table VII

Nephotettix test

(plant-injurious insects)

Active compounds	Active compound concentration in %	Degree of destruction in % after 6[d]
 (1)	0.1	100
 (10)	0.1	100

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CA 2357771 A1 2000/07/13

(21) 2 357 771

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

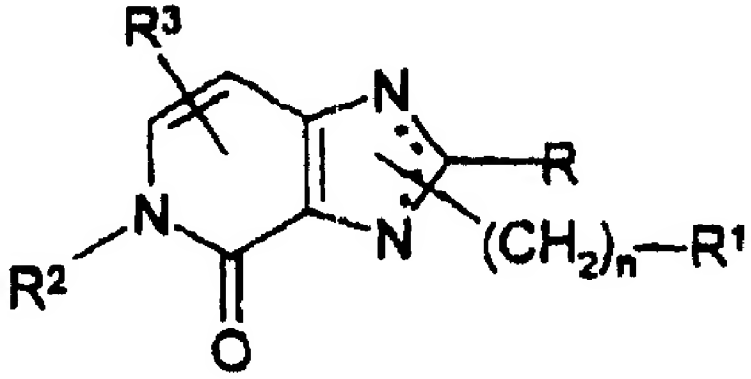
(86) Date de dépôt PCT/PCT Filing Date: 1999/12/21
(87) Date publication PCT/PCT Publication Date: 2000/07/13
(85) Entrée phase nationale/National Entry: 2001/07/06
(86) N° demande PCT/PCT Application No.: EP 99/10236
(87) N° publication PCT/PCT Publication No.: WO 00/40583
(30) Priorité/Priority: 1999/01/08 (199 00 471.4) DE

(51) Cl.Int.^{7}/Int.Cl.^{7} C07D 471/04, A61K 31/437, A61P 9/10, C07D 235/00, C07D 221/00

(71) Demandeur/Applicant:
MERCK PATENT GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, DE

(72) Inventeurs/Inventors:
ANZALI, SOHEILA, DE;
MELZER, GUIDO, DE;
BERNOTAT-DANIELOWSKI, SABINE, DE;
DORSCH, DIETER, DE;
TSAKLAKIDIS, CHRISTOS, DE;
WURZIGER, HANNS, DE;
JURASZYK, HORST, DE;
MEDERSKI, WERNER, DE

(54) Titre : DERIVES D'IMIDAZO[4,5-C]PYRIDINE-4-ONE
(54) Title: IMIDAZO[4,5-C]-PYRIDINE-4-ONE DERIVATIVES



I

(57) Abrégé/Abstract:
The invention relates to novel compounds of formula (I) wherein R, R^1, R^2, R^3 and n have the meaning given in Claim 1. Said compounds are inhibitors of the coagulation factor Xa and can be used for the prophylaxis and/or therapy of thrombo-embolic diseases.

(21) 2 357 771

(13) A1

(74) Agent: FETHERSTONHAUGH & CO.

PCT WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales Büro

INTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)

(51) Internationale Patentklassifikation [7]:		(11) Internationale Veröffentlichungsnummer: WO 00/40583
C07D 471/04, A61K 31/437, A61P 9/10 // (C07D 471/04, 235:00, 221:00)	A3	(43) Internationales Veröffentlichungsdatum: 13. Juli 2000 (13.07.00)

(21) Internationales Aktenzeichen: PCT/EP99/10236

(22) Internationales Anmeldedatum: 21. Dezember 1999 (21.12.99)

(30) Prioritätsdaten:
199 00 471.4 8. Januar 1999 (08.01.99) DE

(71) Anmelder *(für alle Bestimmungsstaaten ausser US)*: MERCK PATENT GMBH [DE/DE]; Frankfurter Strasse 250, D–64293 Darmstadt (DE).

(72) Erfinder; und

(75) Erfinder/Anmelder *(nur für US)*: MEDERSKI, Werner [DE/DE]; Am Ohlenberg 29, D–64390 Erzhausen (DE). JURASZYK, Horst [DE/DE]; Kleiner Ring 14, D–64342 Seeheim (DE). WURZIGER, Hanns [DE/DE]; Greinstrasse 7b, D–64291 Darmstadt (DE). TSAKLAKIDIS, Christos [GR/DE]; Rosenbrunnenstrasse 25, D–69469 Weinheim (DE). DORSCH, Dieter [DE/DE]; Königsberger Strasse 17a, D–64372 Ober–Ramstadt (DE). BERNOTAT–DANIELOWSKI, Sabine [DE/DE]; Liebigstrasse 5, D–61231 Bad Neuheim (DE). MELZER, Guido [AT/DE]; Mörikestrasse 6, D–65719 Hofheim (DE). ANZALI, Soheila [IR/DE]; Am Alten Berg 13, D–64342 Seeheim (DE).

(74) Gemeinsamer Vertreter: MERCK PATENT GMBH; D–64271 Darmstadt (DE).

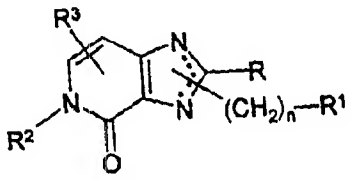
(81) Bestimmungsstaaten: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO Patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI Patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht
Mit internationalem Recherchenbericht.

(88) Veröffentlichungsdatum des internationalen Recherchenberichts: 21. September 2000 (21.09.00)

(54) Title: IMIDAZO[4,5–C]–PYRIDINE–4–ON–DERIVATIVES

(54) Bezeichnung: IMIDAZO[4,5–C]–PYRIDIN–4–ON–DERIVATE



(I)

(57) Abstract

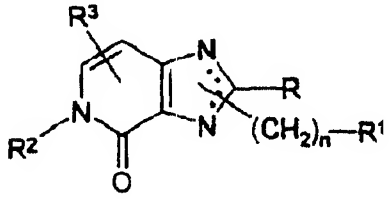
The invention relates to novel compounds of formula (I) wherein R, R^1, R^2, R^3 and n have the meaning given in Claim 1. Said compounds are inhibitors of the coagulation factor Xa and can be used for the prophylaxis and/or therapy of thrombo–embolic diseases.

(57) Zusammenfassung

Neue Verbindungen der Formel (I), worin R, R^1, R^2, R^3 und n die in Patentanspruch 1 angegebene Bedeutung haben, sind Inhibitoren des Koagulationsfaktors Xa und können zur Prophylaxe und/oder Therapie von thromboembolischen Erkrankungen eingesetzt werden.

Imidazo[4,5-c]pyridin-4-one derivatives

The invention relates to compounds of the formula I



I

in which

R is H or unbranched or branched alkyl having 1-6 C atoms or cycloalkyl having 3-6 C atoms,

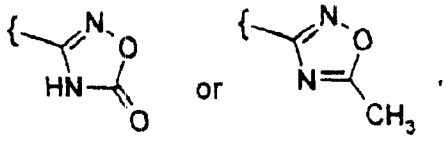
R^1 is Ar,

R^2 is Ar',

R^3 is H, R, R^4, Hal, CN, COOH, COOA or $CONH_2$,

Ar, Ar' are phenyl, naphthyl or biphenyl, in each case independently of one another unsubstituted or mono-, di- or trisubstituted by R, OH, Hal, CN, NO_2, CF_3, NH_2, NHR, NR_2, pyrrolidin-1-yl, piperidin-1-yl, benzyloxy, SO_2NH_2, SO_2NHR, SO_2NR_2, -CONHR, $-CONR_2$, $-(CH_2)_n-NH_2$, $-(CH_2)_n-NHR$, $-(CH_2)_n-NR_2$, $-O-(CH_2)_n-NH_2$, $-O-(CH_2)_n-NHR$, $-O-(CH_2)_n-NR_2$, R^4 or together by $-O-(CH_2)_m-O-$, or are NH_2-substituted isoquinolinyl,

R^4 is $-C(=NH)-NH_2$ which is unsubstituted or monosubstituted by -COR, -COOR, -OH or by a conventional amino protective group or $-NH-C(=NH)-NH_2$, $-C(=O)-N=C(NH_2)_2$,



A is alkyl having 1-4 C atoms,

Hal is F, Cl, Br or I,

m is 1 or 2,

n is 0 or 1,

and their salts and solvates.

The invention also relates to the optically active forms, the racemates, the diastereomers and the hydrates and solvates, e.g. alcoholates, of these compounds.

The invention is based on the object of finding novel compounds having useful properties, in particular those which can be used for the production of medicaments.

It has been found that the compounds of the formula I and their salts have very useful pharmacological properties together with good tolerability. In particular, they show factor Xa-inhibiting properties and can therefore be employed for the control and prevention of thromboembolic disorders such as thrombosis, myocardial infarct, arteriosclerosis, inflammations, apoplexy, angina pectoris, restenosis after angioplasty and intermittent claudication.

The compounds of the formula I according to the invention can furthermore be inhibitors of the clotting factors factor VIIa, factor IXa and thrombin of the blood clotting cascade.

Aromatic amidine derivatives having antithrombotic action are disclosed, for example, in EP 0 540 051 B1. Cyclic guanidines for the treatment of thromboembolic disorders are described, for example, in WO 97/08165. Aromatic heterocycles having factor Xa-inhibitory activity are disclosed, for example, in WO 96/10022. Substituted N-[(aminoiminomethyl)phenylalkyl]-azaheterocyclylamides as factor Xa inhibitors are described in WO 96/40679.

The antithrombotic and anticoagulating effect of the compounds according to the invention is attributed to the inhibiting action against the activated clotting protease, known under the name factor Xa, or to the

inhibition of other activated serine proteases such as factor VIIa, factor IXa or thrombin.

Factor Xa is one of the proteases which is involved in the complex process of blood clotting. Factor Xa catalyses the conversion of prothrombin into thrombin. Thrombin cleaves fibrinogen into fibrin monomers which, after crosslinking, contribute elementarily to thrombus formation. Activation of thrombin can lead to the occurrence of thromboembolic disorders. Inhibition of thrombin, however, can inhibit the fibrin formation involved in thrombus formation.
The inhibition of thrombin can be measured, for example, by the method of G.F. Cousins et al. in *Circulation* **1996**, *94*, 1705-1712.

Inhibition of factor Xa can thus prevent thrombin being formed.
The compounds of the formula I according to the invention and their salts intervene in the blood clotting process by inhibition of factor Xa and thus inhibit the formation of thrombi.

The inhibition of factor Xa by the compounds according to the invention and the anticoagulating and antithrombotic activity can be determined by customary in vitro or in vivo methods. A suitable procedure is described, for example, by J. Hauptmann et al. in *Thrombosis and Haemostatis* **1990**, *63*, 220-223.

The inhibition of factor Xa can be measured, for example, by the method of T. Hara et al. in *Thromb. Haemostas.* **1994**, *71*, 314-319.

After binding to tissue factor, the clotting factor VIIa initiates the extrinsic part of the clotting cascade and contributes to the activation of factor X to factor Xa. Inhibition of factor VIIa thus prevents

the formation of factor Xa and thus subsequent thrombin formation.

The inhibition of factor VIIa by the compounds according to the invention and the anticoagulating and antithrombotic activity can be determined by customary in vitro or in vivo methods. A customary procedure for the measurement of the inhibition of factor VIIa is described, for example, by H.F. Ronning et al. in *Thrombosis Research* **1996**, *84*, 73-81.

The clotting factor IXa is generated in the intrinsic clotting cascade and is likewise involved in the activation of factor X to factor Xa. Inhibition of factor IXa can therefore prevent factor Xa being formed in another way.

The inhibition of factor IXa by the compounds according to the invention and the anticoagulating and antithrombotic activity can be determined by customary in vitro or in vivo methods. A suitable procedure is described, for example, by J. Chang et al. in *Journal of Biological Chemistry* **1998**, *273*, 12089-12094.

The compounds of the formula I can be employed as pharmaceutical active compounds in human and veterinary medicine, in particular for the control and prevention of thromboembolic disorders such as thrombosis, myocardial infarct, arteriosclerosis, inflammations, apoplexy, angina pectoris, restenosis after angioplasty and intermittent claudication.

The invention relates to the compounds of the formula I and their salts, and to a process for the preparation of compounds of the formula I according to Claim 1 and their salts, characterized in that

a) they are set free from one of their functional derivatives by treating with a solvolysing or hydrogenolysing agent, by

i) liberating an amidino group from its oxadiazole derivative or oxazolidinone derivative by hydrogenolysis or solvolysis,

ii) replacing a conventional amino protective group by hydrogen by treating with a solvolysing or hydrogenolysing agent or liberating an amino group protected by a conventional protective group,

or

b) in a compound of the formula I, one or more radicals R, R^1, R^2 and/or R^3 are converted into one or more radicals R, R^1, R^2 and/or R^3,

by, for example

i) hydrolysing an ester group to a carboxyl group

ii) reducing a nitro group

iii) acylating an amino group

iv) converting a cyano group into an amidino group

and/or

c) a base or acid of the formula I is converted into one of its salts.

For all radicals which occur a number of times, it is a condition that their meanings are independent of one another.

Above and below, the radicals and parameters R, R^1, R^2, R^3 and n have the meanings indicated in the formula I, if not expressly stated otherwise.

R is alkyl, is unbranched (linear) or branched, and has 1 to 6, preferably 1, 2, 3, 4, 5 or 6, C atoms. R is preferably methyl, furthermore ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl or tert-butyl, in addition also pentyl, 1-, 2- or 3-methylbutyl, 1,1-, 1,2- or 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1-, 2-, 3- or 4-methylpentyl, 1,1-, 1,2-, 1,3-, 2,2-, 2,3- or 3,3-dimethylbutyl, 1- or 2-ethylbutyl, 1-ethyl-1-methylpropyl, 1-ethyl-2-methylpropyl, 1,1,2- or 1,2,2-trimethylpropyl. R is also cycloalkyl and is preferably cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl or cycloheptyl.

A is alkyl having 1, 2, 3 or 4 C atoms and is preferably methyl, furthermore ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl or tert-butyl.

Hal is preferably F, Cl or Br, but also I.

Ar and Ar' are phenyl, benzodioxol-5-yl, naphthyl or biphenyl, in each case independently of one another unsubstituted or mono-, di- or trisubstituted by R, OH, OR, Hal, CN, NO_2, CF_3, NH_2, NHR, NR_2, pyrrolidin-1-yl, piperidin-1-yl, benzyloxy, SO_2NH_2, SO_2NHA, SO_2NR_2, phenylsulfonamido, $-(CH_2)_n-NH_2$, $-(CH_2)_n-NHR$, $-(CH_2)_n-NR_2$, $-O-(CH_2)_n-NH_2$, $-O-(CH_2)_n-NHR$, $-O-(CH_2)_n-NR_2$, $-O-(CH_2)_m-O-$ or R^4, naphthyl or biphenyl monosubstituted by amidino being preferred. Preferred substituents for biphenyl are amidino, fluorine, SO_2NH_2 or SO_2NHR.

Ar and Ar' are phenyl, naphthyl or biphenyl, in each case independently of one another preferably unsubstituted, phenyl, naphthyl or biphenyl, furthermore preferably, for example, mono-, di- or trisubstituted by methyl, ethyl, propyl, isopropyl, butyl, cyclopentyl, cyclohexyl, fluorine, chlorine, bromine, iodine, hydroxyl, methoxy, ethoxy, propoxy, butoxy, pentyloxy, hexyloxy, cyano, nitro, trifluoromethyl, amino, methylamino, ethylamino,

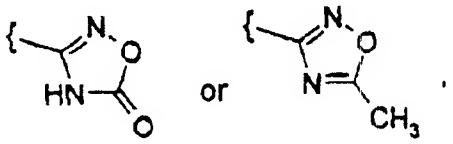
dimethylamino, diethylamino, pyrrolidin-1-yl, piperidin-1-yl, benzyloxy, sulfonamido, methylsulfonamido, ethylsulfonamido, propylsulfonamido, butylsulfonamido, dimethylsulfonamido, phenylsulfonamido, aminomethyl, aminoethyl, N-methylaminomethyl, N-ethylaminomethyl, N,N-dimethylaminomethyl, aminomethyloxy, aminoethyloxy or R^4 and in addition benzodioxolyl.

Ar and Ar' are therefore, in each case independently of one another, very particularly preferably, for example, o-, m- or p-tolyl, o-, m- or p-ethylphenyl, o-, m- or p-propylphenyl, o-, m- or p-isopropylphenyl, o-, m- or p-tert-butylphenyl, o-, m- or p-hydroxyphenyl, o-, m- or p-nitrophenyl, o-, m- or p-aminophenyl, o-, m- or p-(N-methylamino)phenyl, o-, m- or p-(N-methylaminocarbonyl)phenyl, o-, m- or p-acetamidophenyl, o-, m- or p-methoxyphenyl, o-, m- or p-ethoxyphenyl, o-, m- or p-(N,N-dimethylamino)phenyl, o-, m- or p-(N,N-dimethylaminocarbonyl)phenyl, o-, m- or p-(N-ethylamino)phenyl, o-, m- or p-(N,N-diethylamino)phenyl, o-, m- or p-fluorophenyl, o-, m- or p-bromophenyl, o-, m- or p-chlorophenyl, o-, m- or p-(methylsulfonamido)phenyl, o-, m- or p-amidinophenyl, 7-amidino-2-naphthyl, 2'-amidinobiphenyl-3-yl, 3-fluoro-2'-sulfamoylbiphenyl-4-yl, 3-fluoro-2'-N-tert-butylsulfamoylbiphenyl-4-yl, 2'-sulfamoylbiphenyl-4-yl, 2'-N-tert-butylsulfamoylbiphenyl-4-yl, o-, m- or p-(pyrrolidin-1-yl)phenyl, o-, m- or p-(piperidin-1-yl)phenyl, o-, m- or p-{5-methyl[1,2,4]oxadiazol-3-yl)}phenyl, 7-{5-methyl[1,2,4]oxadiazol-3-yl)}naphth-2-yl, o-, m- or p-{5-oxo[1,2,4]oxadiazol-3-yl)}phenyl, 7-{5-oxo[1,2,4]oxadiazol-3-yl)}naphth-2-yl, furthermore preferably 2,3-, 2,4-, 2,5-, 2,6-, 3,4- or 3,5-difluorophenyl, 2,3-, 2,4-, 2,5-, 2,6-, 3,4- or 3,5-dichlorophenyl, 2,3-, 2,4-, 2,5-, 2,6-, 3,4- or 3,5-dibromophenyl, 2,4- or 2,5-dinitrophenyl, 2,5- or 3,4-dimethoxyphenyl, 3-nitro-4-chlorophenyl, 3-amino-4-chloro-, 2-amino-3-chloro-, 2-amino-4-chloro-, 2-amino-

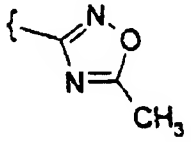
5-chloro- or 2-amino-6-chlorophenyl, 2-nitro-4-N,N-dimethylamino- or 3-nitro-4-N,N-dimethylaminophenyl, 2,3-diaminophenyl, 2,3,4-, 2,3,5-, 2,3,6-, 2,4,6- or 3,4,5-trichlorophenyl, 2,4,6-trimethoxyphenyl, 2-hydroxy-3,5-dichlorophenyl, p-iodophenyl, 3,6-dichloro-4-aminophenyl, 4-fluoro-3-chlorophenyl, 2-fluoro-4-bromophenyl, 2,5-difluoro-4-bromophenyl, 3-bromo-6-methoxyphenyl, 3-chloro-6-methoxyphenyl, 3-chloro-4-acetamidophenyl, 3-fluoro-4-methoxyphenyl, 3-amino-6-methylphenyl, 3-chloro-4-acetamidophenyl or 2,5-dimethyl-4-chlorophenyl.

R^3 is preferably, for example, H, Hal, COOH, COOA or $CONH_2$.

R^4 is preferably, for example, unsubstituted $-C(=NH)-NH_2$, $-NH-C(=NH)-NH_2$, $-C(=O)-N=C(NH_2)_2$, which can also be monosubstituted by OH,

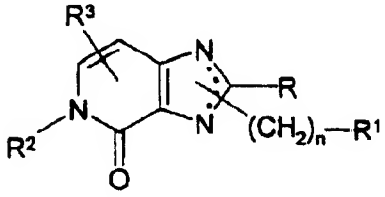


very particularly preferably unsubstituted or OH-substituted $-C(=NH)-NH_2$ or

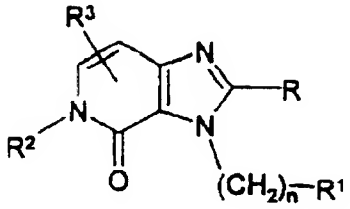


m is 1 or 2.

n is preferably 0 or 1.



is



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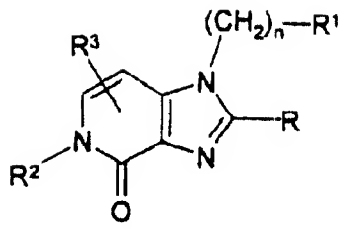
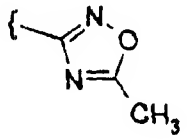
or  (IB).

The compounds of the formula I can have one or more chiral centres and therefore occur in various stereoisomeric forms. The formula I includes all these forms.

Accordingly, the invention relates in particular to those compounds of the formula I in which at least one of the radicals mentioned has one of the preferred meanings indicated above. Some preferred groups of compounds can be expressed by the following subformulae Ia to Ii, which correspond to the formula I and in which the radicals not designated in greater detail have the meaning indicated in the formula I, but in which

in Ia	Ar	is phenyl, naphthyl or biphenyl which is monosubstituted by R^4;
in Ib	Ar'	is phenyl, naphthyl or biphenyl which is monosubstituted by SO_2NH_2 or R^4;
in Ic	Ar, Ar'	are phenyl, naphthyl or biphenyl, in each case independently of one another monosubstituted by SO_2NH_2 or R^4;
in Id	Ar, Ar'	are phenyl, naphthyl or biphenyl, in each case independently of one another monosubstituted by $-CONR_2$, SO_2NH_2 or R^4;
in Ie	R^3	is H, R, Hal, COOH or COOA;
in If	R^4	is SO_2NH_2 or $-C(=NH)-NH_2$ or  ;

in Ig R is unbranched or branched alkyl having 1-6 C atoms or cycloalkyl having 3-6 C atoms,

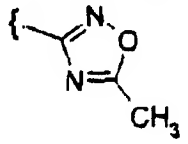
R^1 is Ar,

R^2 is Ar'

R^3 is H, R, Hal, COOH or COOA,

Ar, Ar' are phenyl, naphthyl or biphenyl, in each case independently of one another monosubstituted by $-CONR_2$, SO_2NH_2 or R^4,

R^4 is $-C(=NH)-NH_2$ or



A is alkyl having 1-4 C atoms,

Hal is F, Cl, Br or I,

m is 1 or 2,

n is 0 or

in Ih R is H or unbranched or branched alkyl having 1-6 C atoms or cycloalkyl having 3-6 C atoms,

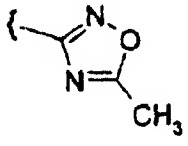
R^1 is Ar,

R^2 is Ar',

R^3 is H, R, Hal, COOH or COOA,

Ar, Ar' are phenyl, naphthyl or biphenyl, in each case independently of one another monosubstituted by SO_2NH_2 or R^4,

R^4 is $-C(=NH)-NH_2$ or



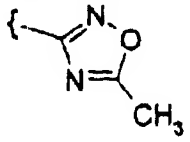
A is alkyl having 1-4 C atoms,

Hal is F, Cl, Br or I,

m is 1 or 2,

n is 0 or 1;

in Ii R is H or unbranched or branched alkyl having 1-6 C atoms or cycloalkyl having 3-6 C atoms,

R^1	is Ar,
R^2	is Ar',
R^3	is H, R, Hal, COOH or COOA,
Ar, Ar'	are phenyl, naphthyl or biphenyl, in each case independently of one another monosubstituted by SO_2NHR or R^4, or are NH_2-substituted isoquinolinyl,
R^4	is unsubstituted or OH-substituted $-C(=NH)-NH_2$ or  ,
A	is alkyl having 1-4 C atoms,
Hal	is F, Cl, Br or I,
m	is 1 or 2,
n	is 0 or 1.

The compounds of the formula I and also the starting substances for their preparation are otherwise prepared by methods known per se, such as are described in the literature (e.g. in the standard works such as Houben-Weyl, Methoden der organischen Chemie [Methods of Organic Chemistry], Georg-Thieme-Verlag, Stuttgart), namely under reaction conditions which are known and suitable for the reactions mentioned. Use can also be made in this case of variants which are known per se, but not mentioned here in greater detail.

The starting substances can, if desired, also be formed in situ, such that they are not isolated from the reaction mixture, but immediately reacted further to give the compounds of the formula I.

Compounds of the formula I can preferably be obtained by setting compounds of the formula I free from one of their functional derivatives by treating with a solvolysing or hydrogenolysing agent.

Preferred starting substances for the solvolysis or hydrogenolysis are those which otherwise correspond to the formula I, but instead of one or more free amino and/or hydroxyl groups contain corresponding protected amino and/or hydroxyl groups, preferably those which, instead of an H atom which is bonded to an N atom, carry an amino protective group, in particular those which, instead of an HN group, carry an R'-N group in which R' is an amino protective group, and/or those which, instead of the H atom of a hydroxyl group, carry a hydroxyl protective group, e.g. those which correspond to the formula I, but instead of a group -COOH carry a group -COOR", in which R" is a hydroxyl protective group.

Preferred starting substances are also the oxadiazole derivatives, which can be converted into the corresponding amidino compounds.

The amidino group can be liberated from its oxadiazole derivative, for example, by treating with hydrogen in the presence of a catalyst (e.g. Raney nickel). Suitable solvents are those indicated below, in particular alcohols such as methanol or ethanol, organic acids such as acetic acid or propionic acid, or mixtures thereof. As a rule, the hydrogenolysis is carried out at temperatures between approximately 0 and 100° and pressures between approximately 1 and 200 bar, preferably at 20-30° (room temperature) and 1-10 bar.

The oxadiazole group is introduced, for example, by reaction of the cyano compounds with hydroxylamine and reaction with phosgene, dialkyl carbonate, chloroformic acid esters, N,N'-carbonyldiimidazole or acetic anhydride.

A number of - identical or different - protected amino and/or hydroxyl groups can also be present in the molecule of the starting substance. If the protective

groups present are different from one another, in many cases they can be removed selectively.

The expression "amino protective group" is generally known and relates to groups which are suitable for protecting (for blocking) an amino group from chemical reactions, but which are easily removable after the desired chemical reaction has been carried out at other positions in the molecule. Typical groups of this type are, in particular, unsubstituted or substituted acyl, aryl, aralkoxymethyl or aralkyl groups. Since the amino protective groups are removed after the desired reaction (or reaction sequence), their nature and size is otherwise not critical; however, those having 1-20, in particular 1-8, C atoms are preferred. The expression "acyl group" is to be interpreted in the widest sense in connection with the present process. It includes acyl groups derived from aliphatic, araliphatic, aromatic or heterocyclic carboxylic acids or sulphonic acids and, in particular, alkoxycarbonyl, aryloxycarbonyl and especially aralkoxycarbonyl groups. Examples of acyl groups of this type are alkanoyl such as acetyl, propionyl, butyryl; aralkanoyl such as phenylacetyl; aroyl such as benzoyl or toluyl; aryloxyalkanoyl such as POA; alkoxycarbonyl such as methoxycarbonyl, ethoxycarbonyl, 2,2,2-trichloroethoxycarbonyl, BOC (tert-butyloxycarbonyl), 2-iodoethoxycarbonyl; aralkyloxycarbonyl such as CBZ ("carbobenzoxy"), 4-methoxybenzyloxycarbonyl, FMOC; arylsulfonyl such as Mtr. Preferred amino protective groups are BOC and Mtr, in addition CBZ, Fmoc, benzyl and acetyl.

The liberation of the compounds of the formula I from their functional derivatives is carried out - depending on the protective group used - for example using strong acids, expediently using TFA or perchloric acid, but also using other strong inorganic acids such as hydrochloric acid or sulphuric acid, strong organic

carboxylic acids such as trichloroacetic acid or sulphonic acids such as benzene- or p-toluenesulphonic acid. The presence of an additional inert solvent is possible, but not always necessary. Suitable inert solvents are preferably organic, for example carboxylic acids such as acetic acid, ethers such as tetrahydrofuran or dioxane, amides such as DMF, halogenated hydrocarbons such as dichloromethane, in addition also alcohols such as methanol, ethanol or isopropanol, and also water. Mixtures of the abovementioned solvents are additionally suitable. TFA is preferably used in an excess without addition of a further solvent, perchloric acid in the form of a mixture of acetic acid and 70% perchloric acid in the ratio 9:1. The reaction temperatures for the cleavage are expediently between approximately 0 and approximately 50°; the reaction is preferably carried out between 15 and 30° (room temperature).

The groups BOC, OBut and Mtr can be removed, for example, preferably using TFA in dichloromethane or using approximately 3 to 5N HCl in dioxane at 15-30°; the FMOC group using an approximately 5 to 50% solution of dimethylamine, diethylamine or piperidine in DMF at 15-30°.

Hydrogenolytically removable protective groups (e.g. CBZ, benzyl) can be removed or the amidino group can be liberated from its oxadiazole derivative, for example by treating with hydrogen in the presence of a catalyst (e.g. of a noble metal catalyst such as palladium, expediently on a support such as carbon). Suitable solvents here are those indicated above, in particular, for example, alcohols such as methanol or ethanol or amides such as DMF. As a rule, the hydrogenolysis takes place at temperatures between approximately 0 and 100° and pressures between approximately 1 and 200 bar, preferably at 20-30° and 1-10 bar. Hydrogenolysis of the CBZ group takes place readily, for example, on 5 to

10% Pd/C in methanol or using ammonium formate (instead of hydrogen) on Pd/C in methanol/DMF at 20-30°.

Suitable inert solvents are, for example, hydrocarbons such as hexane, petroleum ether, benzene, toluene or xylene; chlorinated hydrocarbons such as trichloroethylene, 1,2-dichloroethane, carbon tetrachloride, trifluoromethylbenzene, chloroform or dichloromethane; alcohols such as methanol, ethanol, isopropanol, n-propanol, n-butanol or tert-butanol; ethers such as diethyl ether, diisopropyl ether, tetrahydrofuran (THF) or dioxane; glycol ethers such as ethylene glycol monomethyl or monoethyl ether (methyl glycol or ethyl glycol), ethylene glycol dimethyl ether (diglyme); ketones such as acetone or butanone; amides such as acetamide, dimethylacetamide, N-methylpyrrolidone (NMP) or dimethylformamide (DMF); nitriles such as acetonitrile; sulphoxides such as dimethyl sulphoxide (DMSO); carbon disulphide; carboxylic acids such as formic acid or acetic acid; nitro compounds such as nitromethane or nitrobenzene; esters such as ethyl acetate or mixtures of the solvents mentioned.

The biphenyl-SO_2NH_2 group is preferably employed in the form of its tert-butyl derivative. The tert-butyl group is removed, for example, using TFA with or without addition of an inert solvent, preferably with addition of a small amount of anisole (1% by volume).

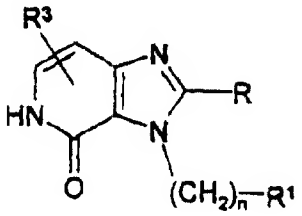
The cyano group is converted into an amidino group by reaction with, for example, hydroxylamine and subsequent reduction of the N-hydroxyamidine with hydrogen in the presence of a catalyst such as, for example, Pd/C.

For the preparation of an amidine of the formula I (e.g. Ar = phenyl monosubstituted by $C(=NH)-NH_2$), ammonia can also be added to a nitrile. The addition is preferably carried out in a number of stages in a manner known per se by a) converting the nitrile using

H_2S into a thioamide, which is converted using an alkylating agent, e.g. CH_3I, into the corresponding S-alkyl imidothioester, which for its part is reacted with NH_3 to give the amidine, b) converting the nitrile into the corresponding imido ester using an alcohol, e.g. ethanol in the presence of HCl, and treating this with ammonia, or c) reacting the nitrile with lithium bis(trimethylsilyl)amide and then hydrolysing the product.

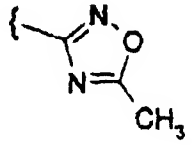
The radical R^1 (if n=0) or R^2 is introduced into the dihydroimidazo[4,5-*c*]pyridin-4-one system by N-arylation (Lit.: Chan et al., Tetrahedron Letters 1998, 39, 2933ff and 2941ff).

Thus it is possible, for example, for preparing compounds of the formula (IA) to react a compound of the formula II

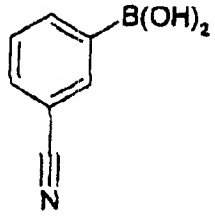


II

in which R has the meaning indicated in Claim 1 and R^1 and R^3 are each a radical of the type which cannot be alkylated, such as, for example, for R^1 a phenyl, benzyl or

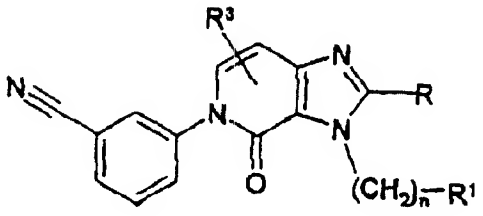
naphthyl radical substituted by  ,

with a compound of the formula III



III

This gives compounds of the formula IV

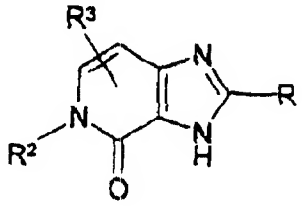


IV.

These are then reacted further to give the compounds according to the invention.

Suitable solvents are those mentioned above. The reaction is carried out in the presence of , for example, Cu(II)(OAc)$_2$. Depending on the conditions used, the reaction time is between a few minutes and 14 days, and the reaction temperature is between approximately 0° and 150°, normally between 15° and 80°.

Analogously, R^2 can also firstly be introduced into the dihydroimidazole (4,5-c]pyridin-4-one system and then a compound of the formula (V)



V

in which R has the meaning indicated in Claim 1 and R^2 and R^3 are each a radical of the type which cannot be alkylated,

can be reacted with a compound of the formula VI

$$R^1-(CH_2)_n-L \qquad VI$$

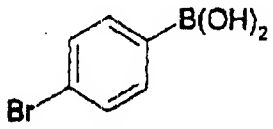
In the compounds of the formula VI, n is 1, R^1 is a radical which cannot be alkylated, such as, for

example, a phenyl radical substituted by 5-methyl[1,2,4]oxadiazol-3-yl, and L is Cl, Br, I or a free or reactive functionally modified OH group.

L is preferably Cl, Br, I or a reactive modified OH group, such as, for example, an activated ester, an imidazolide or alkylsulfonyloxy having 1-6 C atoms (preferably methylsulfonyloxy) or arylsulfonyloxy having 6-10 C atoms (preferably phenyl- or p-tolylsulfonyloxy).

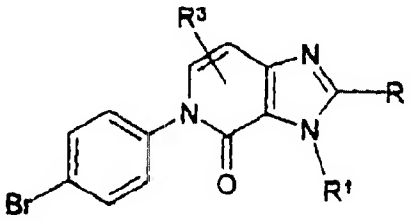
This process gives compounds of the formula (IA) and/or (IB).

If compounds of the formula II in which n is 0 are reacted with compounds of the formula VII



VII

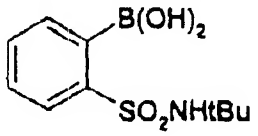
compounds of the formula VIII



VIII

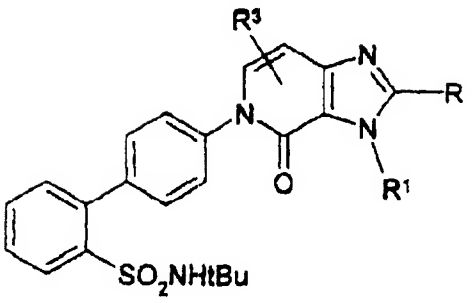
are obtained.

Subsequent reaction of the compounds of the formula VIII with compounds of the formula IX



IX

gives compounds of the formula X



X

The compounds of the formula I are subsequently obtained by cleaving off the tert-butyl group and conversion of the oxidiazole radical into an amidino group.

In addition, it is possible to convert a compound of the formula I into another compound of the formula I by converting one or more radicals R, R^1, R^2 and/or R^3 into one or more radicals R, R^1, R^2 and/or R^3, e.g. by acylating an amino group or reducing nitro groups (for example by hydrogenation on Raney nickel or Pd-carbon in an inert solvent such as methanol or ethanol) to amino groups.

Esters can be hydrolysed, for example, using acetic acid or using NaOH or KOH in water, water-THF or water-dioxane at temperatures between 0 and 100°.

In addition, free amino groups can be acylated in a customary manner using an acid chloride or anhydride or alkylated using an unsubstituted or substituted alkyl halide, expediently in an inert solvent such as dichloromethane or THF and/or in the presence of a base such as triethylamine or pyridine at temperatures between -60 and +30°.

A base of the formula I can be converted into the associated acid addition salt using an acid, for example by reaction of equivalent amounts of the base and of the acid in an inert solvent such as ethanol and subsequent evaporation. Acids suitable for this

reaction are in particular those which yield physiologically acceptable salts. Thus, inorganic acids can be used, e.g. sulphuric acid, nitric acid, hydrohalic acids such as hydrochloric acid or hydrobromic acid, phosphoric acids such as orthophosphoric acid, sulphamic acid, in addition organic acids, in particular aliphatic, alicyclic, araliphatic, aromatic or heterocyclic mono- or polybasic carboxylic, sulphonic or sulphuric acids, e.g. formic acid, acetic acid, propionic acid, pivalic acid, diethylacetic acid, malonic acid, succinic acid, pimelic acid, fumaric acid, maleic acid, lactic acid, tartaric acid, malic acid, citric acid, gluconic acid, ascorbic acid, nicotinic acid, isonicotinic acid, methane- or ethanesulphonic acid, ethanedisulphonic acid, 2-hydroxyethanesulphonic acid, benzenesulphonic acid, p-toluenesulphonic acid, naphthalenemono- and -disulphonic acids, and laurylsulphonic acid. Salts with physiologically unacceptable acids, e.g. picrates, can be used for the isolation and/or purification of the compounds of the formula I.

On the other hand, compounds of the formula I can be converted into the corresponding metal salts, in particular alkali metal or alkaline earth metal salts, or into the corresponding ammonium salts using bases (e.g. sodium or potassium hydroxide or carbonate). Physiologically acceptable organic bases, e.g. ethanolamine can also be used.

Compounds of the formula I according to the invention can be chiral on account of their molecular structure and can accordingly occur in various enantiomeric forms. They can therefore be present in racemic or in optically active form.

Since the pharmaceutical activity of the racemates or of the stereoisomers of the compounds according to the invention can differ, it can be desirable to use the

enantiomers. In these cases, the final product or else even the intermediates can be separated into enantiomeric compounds by chemical or physical measures known to the person skilled in the art, or even employed as such in the synthesis.

In the case of racemic amines, diastereomers are formed from the mixture by reaction with an optically active resolving agent. Suitable resolving agents are, for example, optically active acids, such as the R and S forms of tartaric acid, diacetyltartaric acid, dibenzoyltartaric acid, mandelic acid, malic acid, lactic acid, suitably N-protected amino acids (e.g. N-benzoylproline or N-benzenesulfonylproline) or the various optically active camphorsulphonic acids. Chromatographic resolution of enantiomers with the aid of an optically active resolving agent (e.g. dinitrobenzoylphenylglycine, cellulose triacetate or other derivatives of carbohydrates or chiral derivatized methacrylate polymers attached to silica gel) is also advantageous. Suitable eluents for this are aqueous or alcoholic solvent mixtures such as, for example, hexane/isopropanol/acetonitrile, e.g. in the ratio 82:15:3.

The invention further relates to the use of the compounds of the formula I and/or their physiologically acceptable salts for the production of pharmaceutical preparations, in particular in a non-chemical manner. In this connection, they can be brought into a suitable dose form together with at least one solid, liquid and/or semi-liquid excipient or auxiliary and, if appropriate, in combination with one or more other active compounds.

The invention further relates to pharmaceutical preparations comprising at least one compound of the formula I and/or one of its physiologically acceptable salts.

These preparations can be used as medicaments in human or veterinary medicine. Possible excipients are organic or inorganic substances which are suitable for enteral (e.g. oral) or parenteral administration or topical application and do not react with the novel compounds, for example water, vegetable oils, benzyl alcohols, alkylene glycols, polyethylene glycols, glycerol triacetate, gelatin, carbohydrates such as lactose or starch, magnesium stearate, talc, petroleum jelly. Tablets, pills, sugar-coated tablets, capsules, powders, granules, syrups, juices or drops, in particular, are used for oral administration, suppositories are used for rectal administration, solutions, preferably oily or aqueous solutions, in addition to suspensions, emulsions or implants, are used for parenteral administration, and ointments, creams or powders are used for topical application. The novel compounds can also be lyophilized and the lyophilizates obtained used, for example, for the production of injection preparations. The preparations indicated can be sterilized and/or can contain auxiliaries such as lubricants, preservatives, stabilizers and/or wetting agents, emulsifiers, salts for affecting the osmotic pressure, buffer substances, colourants, flavourings and/or one or more further active compounds, e.g. one or more vitamins.

The compounds of the formula I and their physiologically acceptable salts can be used in the control and prevention of thromboembolic disorders such as thrombosis, myocardial infarct, arteriosclerosis, inflammations, apoplexy, angina pectoris, restenosis after angioplasty and intermittent claudication.

In this connection, as a rule the substances according to the invention are preferably administered in doses of between approximately 1 and 500 mg, in particular between 5 and 100 mg, per dose unit. The daily dose is

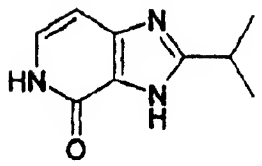
preferably between approximately 0.02 and 10 mg/kg of bodyweight. The specific dose for each patient depends on all sorts of factors, however, for example on the efficacy of the specific compound employed, on the age, bodyweight, general state of health, sex, on the diet, on the time and route of administration, and on the excretion rate, pharmaceutical combination and severity of the particular disorder to which the therapy applies. Oral administration is preferred.

Above and below, all temperatures are indicated in °C. In the following examples, "customary working up" means: water is added, if necessary, the mixture is adjusted, if necessary, depending on the constitution of the final product, to a pH of between 2 and 10 and extracted with ethyl acetate or dichloromethane, the extract is separated off, the organic phase is dried over sodium sulfate and evaporated, and the residue is purified by chromatography on silica gel and/or by crystallization. R_f values on silica gel; eluent: ethyl acetate/methanol 9:1.

Mass spectrometry (MS): EI (electron impact ionization) M^+
FAB (fast atom bombardment) $(M+H)^+$

Example 1

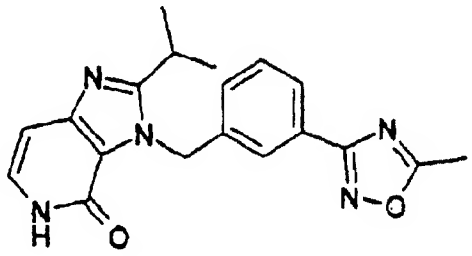
140 ml of isobutyric acid and 250 ml of fuming hydrochloric acid are added to 50.0 g of 3,4-diamino-2-chloropyridine. The reaction mixture is heated under reflux for 7 days. It is poured into ice water, the deposited precipitate is separated off and 2-isopropyl-3,5-dihydroimidazo[4,5-c]pyridin-4-one ("AB"), m.p. 310-311° (decomposition), EI 177 is obtained



"AB".

A mixture of "AB" and 4-chloro-2-isopropyl-3*H*-imidazo[4,5-*c*]pyridine is found in the mother liquor.

A solution of 0.877 g of "AB" and 0.691 g of potassium carbonate in 30 ml of DMF is stirred at room temperature for 30 minutes. 1.5 g of 3-(3-bromomethylphenyl)-5-methyl[1,2,4]oxadiazole are added and the mixture is stirred for 16 hours and worked up in the customary manner. After chromatography over silica gel, in addition to the two regioisomeric dialkylation products, the compound 2-isopropyl-3-[3-(5-methyl[1,2,4]oxadiazol-3-yl)benzyl]-5*H*-imidazo[4,5-*c*]-pyridin-4-one ("CA") is obtained



"CA".

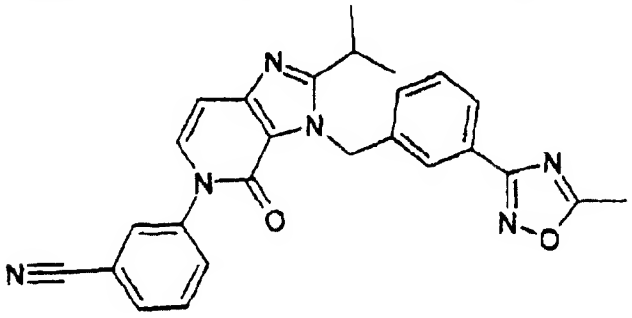
An alternative process leads to "CA" as follows (analogously to Mederski et al., J. Med. Chem. **1994**, 1632 ff):

reaction of 3,4-diamino-2-chloropyridine with isobutyric anhydride to give N-(4-amino-2-chloropyridin-3-yl)isobutyramide. The subsequent reaction with 3-(3-bromomethylphenyl)-5-methyl[1,2,4]oxadiazole leads to a mixture of 4-chloro-2-isopropyl-3-[3-(5-methyl[1,2,4]oxadiazol-3-yl)benzyl]-3*H*-imidazo[4,5-*c*]pyridine and N-(4-amino-2-chloropyridin-3-yl)-N-[3-(5-methyl[1,2,4]oxadiazol-3-yl)benzyl]-isobutyramide. Both compounds are reacted to give "CA".

A solution of 0.4 g of "CA" in 10 ml of DMF is mixed with 0.5 g of the compound of the formula III, 258 mg of Cu(II)$(OAc)_2$ in 50 ml of dichloromethane and 1 g of molecular sieve (0.4 nm), and the mixture is stirred at room temperature for 4 days.

The molecular sieve is removed, and customary work-up gives the compound

2-isopropyl-3-[(5-methyl[1,2,4]oxadiazol-3-yl)-benzyl]-5-(3-cyanophenyl)-3,5-dihydroimidazo-[4,5-*c*]pyridin-4-one ("BC1"), 345 mg, m.p. 168°, EI 450



"BC1".

330 mg of BC1 are suspended in 20 ml of ethanol, and 490 mg of sodium bicarbonate and 407 mg of hydroxylammonium chloride are then added successively. After further addition of 2 ml of water, the mixture is boiled under reflux for 5 hours. 50 ml of ice-water are added, and customary work-up gives 280 mg of 2-isopropyl-3-[(5-methyl[1,2,4]oxadiazol-3-yl)benzyl]-5-(3-N-hydroxyamidinophenyl)-3,5-dihydroimidazo-[4,5-*c*]pyridin-4-one ("BC2"), EI 483.

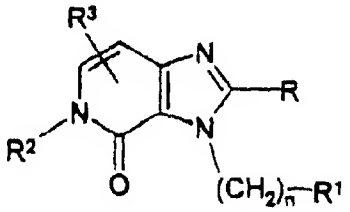
Analogously, the compound 2-isopropyl-3-(7-cyanonaphth-2-ylmethyl)-5*H*-imidazo[4,5-c]-pyridin-4-one is obtained by reacting the compound "AB" with 2-bromomethyl-7-cyanonaphthalene, followed by work-up. Analogous reaction with the compound of the formula III as described above gives the compound 2-isopropyl-3-(7-cyanonaphth-2-ylmethyl)-5-(3-cyanophenyl)-3,5-dihydro-imidazo[4,5-c]pyridin-4-one, EI: [M^+] 443 (74%), 166 (100%).

Subsequent reaction with hydroxylammonium chloride gives 2-isopropyl-3-(7-N-hydroxyamidinonaphth-2-ylmethyl)-5-(3-N-hydroxyamidinophenyl)-3,5-dihydroimidazo[4,5-c]pyridin-4-one, EI: [M^+] 509 (8%), 166 (100%).

Example 2

A solution of 0.27 g of "BC2" in 20 ml of methanol is admixed with 100 mg of Raney nickel and a drop of acetic acid, and the mixture is hydrogenated at room temperature for 8 hours. The catalyst is filtered off and the solvent is removed, giving the compound 2-isopropyl-3-(3-amidinobenzyl)-5-(3-amidinophenyl)-3,5-dihydroimidazo[4,5-c]pyridin-4-one, FAB 428.

The compounds 2-65 of the formula IA listed in Table 1 are obtained analogously to Examples 1 and/or 2



IA

Table 1

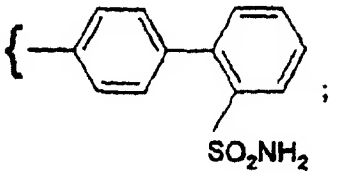
No.	R	R^1	R^2	R^3	n	m.p.	EI (FAB)
2	H	(1)	(1)	H	1	119-120°	
3	Me	(1)	(1)	H	1		
4	Et	(1)	(1)	H	1		
5	t-Bu	(1)	(1)	H	1	>300°	
6	H	(1)	(1)	H	0		
7	Me	(1)	(1)	H	0		
8	Et	(1)	(1)	H	0		
9	i-Pr	(1)	(1)	H	0		
10	t-Bu	(1)	(1)	H	0		

No.	R	R^1	R^2	R^3	n	m.p.	EI (FAB)
11	H	(1)	(2)	H	0		
12	Me	(1)	(2)	H	0		
13	Et	(1)	(2)	H	0		
14	i-Pr	(1)	(2)	H	0		
15	t-Bu	(1)	(2)	H	0		
16	H	(1)	(2)	H	1	149-150°	
17	Me	(1)	(2)	H	1		
18	Et	(1)	(2)	H	1		
19	i-Pr	(1)	(2)	H	1		
20	t-Bu	(1)	(2)	H	1		
21	H	(3)	(1)	H	1		[M+H] 437 (2%) 131 (100%)
22	Me	(3)	(1)	H	1		
23	Et	(3)	(1)	H	1		[M+H] 464 (8%) 91 (100%)
24	i-Pr	(3)	(1)	H	1		[M+H] 478 (9%) 131 (100%)
25	t-Bu	(3)	(1)	H	1		
26	H	(1)	(4)	H	0		
27	Me	(1)	(4)	H	0		
28	Et	(1)	(4)	H	0		
29	i-Pr	(1)	(4)	H	0		
30	t-Bu	(1)	(4)	H	0		
31	H	(1)	(4)	H	1		
32	Me	(1)	(4)	H	1		
33	Et	(1)	(4)	H	1		
34	i-Pr	(1)	(4)	H	1		
35	t-Bu	(1)	(4)	H	1		
36	H	(1)	(5)	H	0		
37	Me	(1)	(5)	H	0		
38	Et	(1)	(5)	H	0		
39	i-Pr	(1)	(5)	H	0		

No.	R	R^1	R^2	R^3	n	m.p.	EI (FAB)
40	t-Bu	(1)	(5)	H	0		
41	H	(1)	(5)	H	1		
42	Me	(1)	(5)	H	1		
43	Et	(1)	(5)	H	1		
44	i-Pr	(1)	(5)	H	1		
45	t-Bu	(1)	(5)	H	1		
46	H	(3)	(2)	H	1		
47	Me	(3)	(2)	H	1		
48	Et	(3)	(2)	H	1		
49	i-Pr	(3)	(2)	H	1		
50	t-Bu	(3)	(2)	H	1		
51a	iso-Bu	(10)	(9)	H	1		[M+H] 514 (16%) 223 (100%)
51b	iso-Bu	(10)	(16)	H	1		[M+H] 548 (38%) 166 (100%)
51c	iso-Bu	(3)	(1)	H	1	244°	
52	i-Pr	(6)	(7)	H	1	188°	[M+H] 560 (52%) 424 (100%)
53	Bu	(1)	(1)	H	1	214-215°	
54	Bu	(6)	(8)	H	1	220-221°	
55	Bu	(9)	(9)	H	1	166-167°	
56	Bu	(3)	(1)	H	1	244-245°	
57	Bu	(10)	(8)	H	1	169-170°	
58	Bu	(1)	(4)	H	1	128° (decomp.)	[M+H] 555 (94%) 91 (100%)
59	Bu	(6)	(11)	H	1	175°	
60	Pe	(1)	(1)	H	1	191°	
61	Bu	(12)	(8)	H	1	187-188°	
62	Bu	(13)	(8)	H	1	120-121°	
63	Bu	(13)	(1)	H	1	137-138°	
64	(14)	(15)	(1)	H	1	88-89°	
65	Pe	(15)	(1)	H	1	145°	

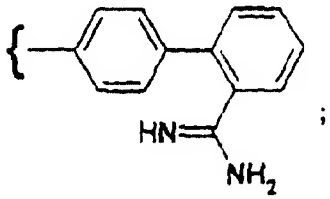
(1) = 3-amidinophenyl; (2) = 2-aminosulfonylphenyl;

(3) = 7-amidinonaphth-2-yl;

(4) = 

;

(5) =

(6) = 

;

(6) = 3-[(5-methyl-[1,2,4]-oxadiazol-3-yl)phenyl;
(7) = 2-(N-tert-butylaminosulphonyl)phenyl;
(8) = 3-aminocarbonylphenyl;
(9) = 3-cyanophenyl;
(10) = 7-[(5-methyl-[1,2,4]-oxadiazol-3-yl)naphth-2-yl;
(11) = 4-bromophenyl;
(12) = 3-(N-tert-butylaminosulphonyl)phenyl;
(13) = 3-aminosulphonylphenyl;
(14) = cyclopentylmethyl;
(15) = 1-aminoisoquinolin-7-yl;
(16) = 3-N-hydroxyamidinophenyl;

Me = methyl; Et = ethyl; i-Pr = isopropyl; Bu = n-butyl; t-Bu = tert-butyl; iso-Bu = isobutyl; Pe = Pentyl

The examples below relate to pharmaceutical preparations:

Example A: Injection vials

A solution of 100 g of an active compound of the formula I and 5 g of disodium hydrogen phosphate is adjusted to pH 6.5 in 3 l of double-distilled water

using 2N hydrochloric acid, sterile-filtered, dispensed into injection vials, lyophilized under sterile conditions and aseptically sealed. Each injection vial contains 5 mg of active compound.

Example B: Suppositories

A mixture of 20 g of an active compound of the formula I is fused with 100 g of soya lecithin and 1400 g of cocoa butter, poured into moulds and allowed to cool. Each suppository contains 20 mg of active compound.

Example C: Solution

A solution of 1 g of an active compound of the formula I, 9.38 g of $NaH_2PO_4 \cdot 2\ H_2O$, 28.48 g of $Na_2HPO_4 \cdot 12\ H_2O$ and 0.1 g of benzalconium chloride in 940 ml of double-distilled water is prepared. It is adjusted to pH 6.8, made up to 1 l and sterilized by irradiation. This solution can be used in the form of eye drops.

Example D: Ointment

500 mg of active compound of the formula I are mixed with 99.5 g of petroleum jelly under aseptic conditions.

Example E: Tablets

A mixture of 1 kg of active compound of the formula I, 4 kg of lactose, 1.2 kg of potato starch, 0.2 kg of talc and 0.1 kg of magnesium stearate is compressed in a customary manner to give tablets, such that each tablet contains 10 mg of active compound.

Example F: Sugar-coated tablets

Analogously to Example E, tablets are pressed and are then coated in a customary manner using a coating of sucrose, potato starch, talc, tragacanth and colorant.

Example G: Capsules

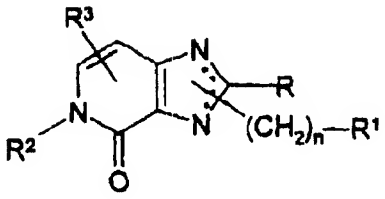
2 kg of active compound of the formula I are dispensed into hard gelatin capsules in a customary manner such that each capsule contains 20 mg of the active compound.

Example H: Ampoules

A solution of 1 kg of active compound of the formula I in 60 l of double-distilled water is sterile-filtered, dispensed into ampoules, lyopholized under sterile conditions and aseptically sealed. Each ampoule contains 10 mg of active compound.

Patent Claims

1. Compounds of the formula I



I

in which

R is H or unbranched or branched alkyl having 1-6 C atoms or cycloalkyl having 3-6 C atoms,

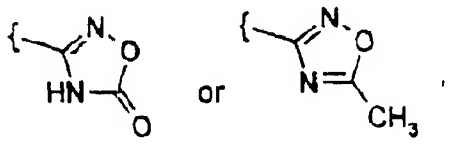
R^1 is Ar,

R^2 is Ar',

R^3 is H, R, R^4, Hal, CN, COOH, COOA or $CONH_2$,

Ar, Ar' are phenyl, naphthyl or biphenyl, in each case independently of one another unsubstituted or mono-, di- or trisubstituted by R, OH, Hal, CN, NO_2, CF_3, NH_2, NHR, NR_2, pyrrolidin-1-yl, piperidin-1-yl, benzyloxy, SO_2NH_2, SO_2NHR, SO_2NR_2, -CONHR, $-CONR_2$, $-(CH_2)_n-NH_2$, $-(CH_2)_n-NHR$, $-(CH_2)_n-NR_2$, $-O-(CH_2)_n-NH_2$, $-O-(CH_2)_n-NHR$, $-O-(CH_2)_n-NR_2$, R^4 or together by $-O-(CH_2)_m-O-$,
or are NH_2-substituted isoquinolinyl,

R^4 is $-C(=NH)-NH_2$ which is unsubstituted or monosubstituted by -COR, -COOR, -OH or by a conventional amino protective group or $-C(=NH)-NH_2$ or $-NH-C(=NH)-NH_2$, $-C(=O)-N=C(NH_2)_2$,



A is alkyl having 1-4 C atoms,

Hal is F, Cl, Br or I,
m is 1 or 2,
n is 0 or 1,
and their salts and solvates.

2. Compounds according to Claim 1

a) 2-isopropyl-3-(3-amidinobenzyl)-5-(3-amidinophenyl)-3,5-dihydroimidazo[4,5-c]pyridin-4-one;
and their salts.

and their salts and solvates.

3. Process for preparing compounds of the formula I according to Claim 1, and their salts, characterized in that

a) they are set free from one of their functional derivatives by treating with a solvolysing or hydrogenolysing agent, by

i) liberating an amidino group from its oxadiazole derivative or oxazolidinone derivative by hydrogenolysis or solvolysis,

ii) replacing a conventional amino protective group by hydrogen by treating with a solvolysing or hydrogenolysing agent or liberating an amino group protected by a conventional protective group,

or

b) in a compound of the formula I, one or more radicals R, R^1, R^2 and/or R^3 are converted into one or more radicals R, R^1, R^2 and/or R^3,

by, for example

i) hydrolysing an ester group to a carboxyl group,

ii) reducing a nitro group,

iii) acylating an amino group,

iv) converting a cyano group into an amidino group

and/or

c) a base or acid of the formula I is converted into one of its salts.

4. Process for producing pharmaceutical preparations, characterized in that a compound of the formula I according to Claim 1 and/or one of its physiologically acceptable salts is brought into a suitable dosage form together with at least one solid, liquid or semi-liquid excipient or auxiliary.

5. Pharmaceutical preparation, characterized in that it comprises at least one compound of the formula I according to Claim 1 and/or one of its physiologically acceptable salts.

6. Compounds of the formula I according to Claim 1 and their physiologically acceptable salts or solvates as pharmaceutically active compounds.

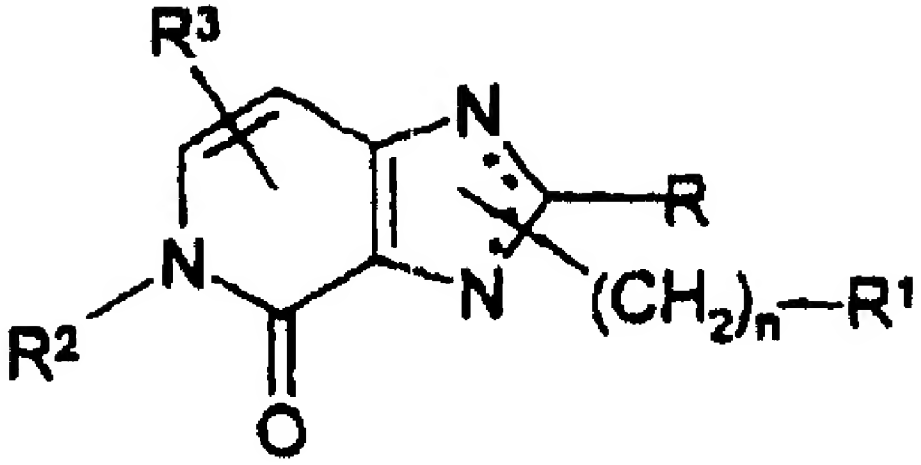
7. Compounds of the formula I according to Claim 1 and their physiologically acceptable salts for controlling thromboses, myocardial infarct, arteriosclerosis, inflammations, apoplexy, angina pectoris, restenosis after angioplasty and intermittent claudication.

8. Medicaments of the formula I according to Claim 1 and their physiologically acceptable salts as inhibitors of the coagulation factor Xa.

9. Use of compounds of the formula I according to Claim 1 and/or their physiologically acceptable salts for producing a medicament.

10. Use of compounds of the formula I according to Claim 1 and/or their physiologically acceptable salts in the control of thromboses, myocardial infarct, arteriosclerosis, inflammations, apoplexy, angina pectoris, restenosis after angioplasty and intermittent claudication.

Fetherstonhaugh & Co.
Ottawa, Canada
Patent Agents



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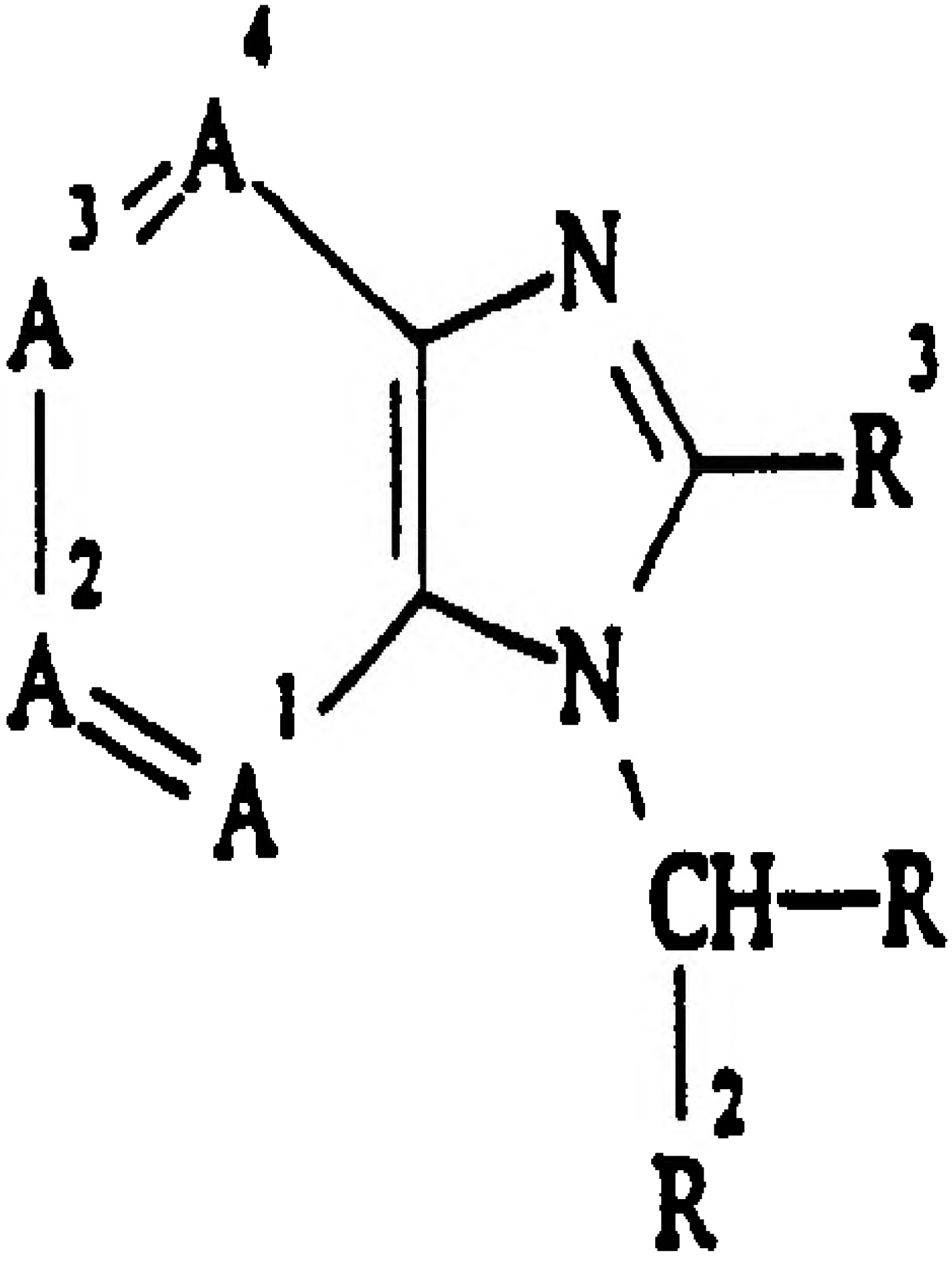
4
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CH—R
2
R